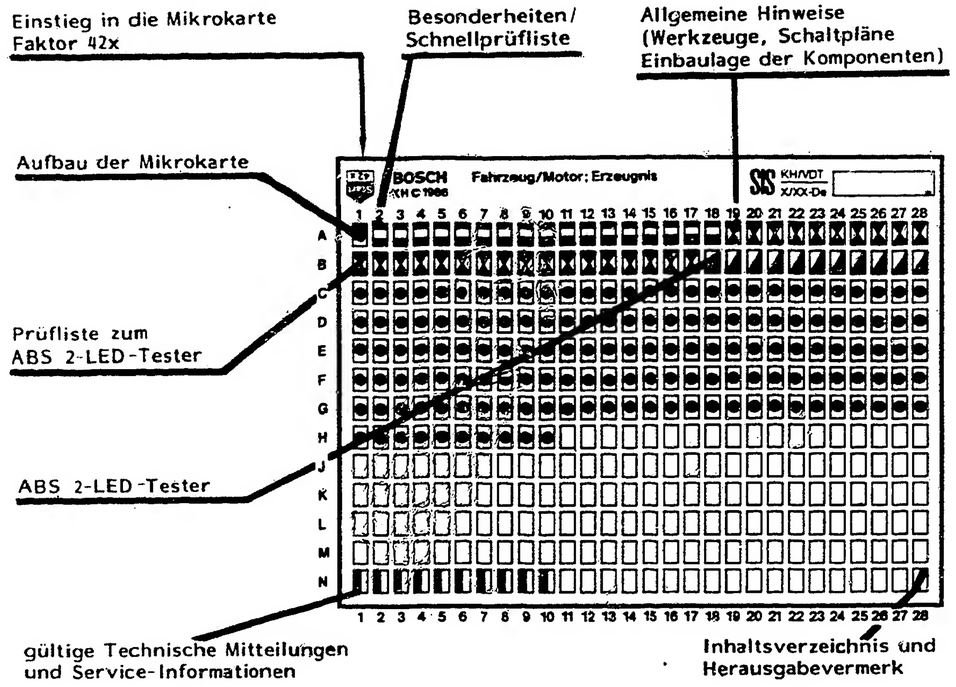


MICROFICHE LAYOUT

1. Read from left to right.

2. Title of microfiche (appears on each coordinate).

E16	Product/assembly/test step	

Coordinate

3. Limits of section

==>	<==>	<==	=> <=
Beginning	Mid-section	End	One page section

4. Vehicle-specific special features are marked on the coordinates A27...A28 with the adjacent symbol (e.g. installation positions etc.). #

A01	—	=> <=

SPECIAL FEATURES

This microcard applies to ABS testing with the ABS-tester ETT 016.00 (0 684 101 600) for the following vehicles:

* MERCEDES-BENZ Type 107/116/123/126

  as of series start.
  Model year '85 has been included.

The ABS in Mercedes-Benz has 3 wheel-speed sensors and one 3-circuit hydraulic modulator for front/rear-axle braking-force distribution.

RAPID DIAGNOSIS CHART FOR ABS TESTER

The following rapid diagnosis chart makes it possible for the experienced ABS specialist to rapidly check the ABS system using the ABS tester.

If detailed information and instructions are necessary, the last column refers to the coordinates containing the detailed test step.

The following test requirements must be met prior to testing with the ABS tester.

A02	—	==>

Test requirements for testing with the ABS tester

* The tester must have been converted to the latest technical standard (designation "U2" on nameplate or as of FD 352).

* Check ground connection of return pump and over-voltage-protection relay term. 31 for firm seating and corrosion.

* Check hydraulic connections and sealing points on hydraulic modulator for leakage (visual inspection).

* If the ABS warning lamp sometimes lights up during driving (e.g. after switching on consuming devices) and then goes out again by itself, check the battery and voltage supply (generator, regulator, and voltage drops).

* If the ABS warning lamp continually lights up and does not go out, check the following points:

-> Does the multiple plug show correct seating at the controller, and is it engaged?
Are all plug contacts OK?
Are all spring contacts engaged?
-> Is V-belt torn?
(Generator delivers no voltage, charge and ABS warning lamps come on).
-> Does generator term. 61 deliver voltage?
Are plug connection and lead to ABS controller OK?
-> Check for loose contacts for wheel-speed sensors in program-switch position 10.

* Switch on ignition in all program-switch positions for testing with the tester (tester uses current from vehicle battery).

* Observe tester lamps 1 and 2 in all program-switch positions.

I M P O R T A N T !

Do not drive with tester connected!

The entire test program should be repeated after every repair.

General trouble-shooting information

Check all leads for ground connection and contact with positive leads, as well as looking out for abrasion and pinching.

* Connect ABS tester to controller and ABS wiring harness.

I M P O R T A N T !

Connect and disconnect the controller only with the ignition switched off.

The installation position of the controller is as follows:

- Type 107/116:
Behind the right footwell support.

- Type 123:
Behind the right footwell covering.

- Type 126:
In the equipment space between the windshield-washer motor.

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
1...24	Voltage supply for every test step	1 (+) and 10 (-)	Ignition on	Lamp 1 (green) must light up under every test step	C05
1	Valve relay - rest position	32 and 10	Ignition on	Lamp 1 (green) and lamp 3 (green) must light up	C11
2	Valve relay - operation	32 and 10 Neg. to 27.	Ignition on	Lamp 1 (green) and lamp 3 (green) must light up	C13
3	Motor relay - rest position	14 and 10	Ignition on	Lamp 1 (green) and lamp 3 (green) must light up	C15
4	Motor relay - operation	14 and 10 Neg. to 28.	Ignition on. Press illuminated key.	Lamp 1 (green) and lamp 3 (green) must light up. Pump motor running.	C17
5	Valid for 4-pin overvoltage-protection relay up to approx. 8.85. Overvoltage-protection relay (installed fuse and Zener diode only).	1 and 10	Ignition off. Disconnect controller. Insert relay of vehicle into test plug at back of tester by means of adapter lead. Insert new relay into vehicle. Switch on ignition, wait approx. 1 s., and then press illuminated key. After testing, switch off ignition and re-connect controller.	Lamp 1 (green) must be lit constantly. After the illuminated key is pressed, lamp 3 (green) must light up.	C19
	Valid for 5-pin overvoltage-protection relay as of approx. 8.85. Test with tester not applicable. Test Zener diode in overvoltage-protection relay, using ohmmeter as an alternative, in forward and reverse directions.				

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
6	Internal resistances of solenoid-operated valves in hydraulic modulator		Ignition on.	Lamp 1 (green) must be lit constantly.	C21
		2 and 32	Press button VL:	VL: 0,7...1,7 Ω	
		35 and 32	Press button VR:	VR: 0,7...1,7 Ω	
		18 and 32	Press button HA:	HA: 0,7...1,7 Ω	
7	Ground to terminal 10	10	Ignition on. Press illuminated key.	Lamp 1 (green) must be lit constantly. 30...300 mV	D01
8	Ground to terminal 34	34	Ignition on. Press illuminated key.	Lamp 1 (green) must be lit constantly. 10...250 mV	D03
9	Ground to terminal 20	20	Ignition on. Press illuminated key.	Lamp 1 (green) must be lit constantly. 10...250 mV	D05
10	Internal resistances of wheel-speed sensors		Ignition on.	Lamp 1 (green) must be lit constantly.	D07
		4 and 6	Press button VL:	0,9...2,3 k Ω	
		21 and 23	Press button VR:	0,9...2,3 k Ω	
		7 and 9	Press button HA:	0,6...1,6 k Ω	
			Modular wheel-speed sensor (as of approx. 4.85:)		
		4 and 6	Press button VL:	0,6...1,6 k Ω	
		21 and 23	Press button VR:	0,6...1,6 k Ω	
11	Insulation resistances of wheel-speed sensors		Ignition on.	Lamp 1 (green) must be lit constantly.	D23
		6 and 10	Press button VL:	20...999 k Ω	
		23 and 10	Press button VR:	20...999 k Ω	
		7 and 10	Press button HA:	20...999 k Ω	

A07 — <⟹>

A08 — <⟹>

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
12	DC voltage on the wheel-speed-sensor leads	6 and 10 23 and 10 7 and 10	Ignition on. Press button VL: Press button VR: Press button HA:	Lamp 1 (green) must be lit constantly. VL: 000 ... 100 mV VR: 000 ... 100 mV HA: 000 ... 100 mV	E07
13	Controller-internal supply voltage	12 and 10	Ignition on. Press illuminated key:	Lamp 1 (green) must be lit constantly. 8,85...9,15 V As of 1984, valid for generation 2 B: 4,75...5,25 V	E19
14	Diode (in hydraulic modulator) in forward direction and ABS warning lamp	29 and 32	Ignition on.	0,4...1,5 V ABS warning lamp in vehicle must light up.	E21
15	Diode (in hydraulic modulator) in reverse direction	29 and 32 Neg. to 29	Ignition on.	1,5...8,5 V ABS warning lamp lights up not so brightly.	F03
16	Controller, BITE triggering (BITE = Built-In Test Equipment)	29 and +	Ignition on. Press illuminated key for min. of 3 seconds:	ABS warning lamp must go out after max. of 1 second.	F11
17	Controller, BITE fault simulation	29 and +	Ignition on. Press illuminated key for min. of 3 seconds:	ABS warning lamp must be lit constantly (flickering after approx. 1 second permissible).	F13

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
18	Controller, current for pressure-holding		Ignition on.	Lamp 1 (green) must be lit constantly.	F15
		2	Press button VL, press illuminated key:	VL: 1,9...2,3 A	
		35	Press button VR, press illuminated key:	VR: 1,9...2,3 A	
		18	Press button HA, press illuminated key:	HA: 1,9...2,3 A	
19	Controller, current for pressure reduction		Ignition on.	Lamp 1 (green) must be lit constantly.	F17
		2	Press button VL, press illuminated key:	VL: 4,5...6,0 A	
		35	Press button VR, press illuminated key:	VR: 4,5...6,0 A	
		18	Press button HA, press illuminated key:	HA: 4,5...6,0 A	
24	Voltage of stop-lamp switch. Valid as of generation 2 B (as of 9.83).	25 and 10	Ignition on. Actuate brake pedal:	10...15 V	F19

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

A brake dynamometer (BPS) is required for the program-selector-switch positions 20, 21, 22 and 23. Do not run the vehicle with the tester connected! Do not use a brake-pedal actuating device for adjusting the braking force! Always give priority to program-selector-switch position 23.
Front axle
Run front wheels of vehicle onto the brake dynamometer. Pull on the hand brake.

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
23	Wheel-speed-sensor signal and test for mix-up	4 and 6	Press button VL, switch on left-hand dynamometer roller.	VL: 1,9...19	F23
		21 and 23	Press button VR, switch off left-hand dynamometer roller, switch on right-hand dynamometer roller.	VR: 1,9...19	G01
20	Hydraulic-modulator pressure reduction and test for mix-up	Current supply to term.35	Press button VR. Switch on right-hand dyn. rol. Actuate brake pedal and hold 2000 N constant. Press illuminated key.	VR: 500...1100 N	G07
		Current supply to term.2	Press button VL. Switch off right-hand dyn. rol. Switch on left-hand dyn. rol. Actuate brake pedal and hold 2000 N constant. Press illuminated key.	VL: 500...1100 N	G11
21	Hydraulic-modulator pressure buildup	Current supply to term.2	Press button VL, switch on both dyn. rollers. Actuate brake pedal and hold 2000 N constant. Permissible difference between both wheels = max. 500 N Press illuminated key.	Indicator of brake dynamometer moves to left to an intermediate value and rises again to VL: 1000...1700 N	G15

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
21	Hydraulic-modulator pressure buildup	Current supply to term.35	Press button VR. Switch on both dyn. rollers. Actuate brake pedal and hold 2000 N constant. Press illuminated key.	Indicator of brake dynamometer moves to right to an intermediate value and rises again to VR: 1000...1700 N	G17
22	Hydraulic-modulator pump delivery rate, front axle.	Current supply to term.35 and term.2	Switch on both dyn. rollers. Read off intrinsic friction factor. Press button VA. Actuate brake pedal and hold 2000 N constant. Press illuminated key.	After an intermediate value at both sides, return supply pump is briefly switched on. Reading at both sides must drop below intrinsic friction factor plus max.500 N. Press illuminated key until reading rises again to 2000 N.	G19

RAPID DIAGNOSIS CHART FOR ABS TESTER (CONTINUED)

Rear axle:
Run rear wheels of vehicle onto brake dynamometer. Release hand brake.
In the case of automatice vehicles, position selection switch to position "N".

Program switch position	Under test	Measurement at controller terminals	Additional operation	Test specifications (reading)	For trouble-shooting, see coordinates
23	Wheel-speed-sensor signal and test for mix-up	7 and 9	Press button HA, switch on both dynamometer rollers.	HA: 1,9...19	G21
20	Hydraulic modulator Pressure reduction and test for mix-up	Current supply to term.18	Press button HA. Switch on both dynamometer rollers. Actuate brake pedal and hold 2000 N constant. Permissible difference between both wheels = max. 500 N. Press illuminated key.	HA: 500...1100 N	G27
21	Hydraulic-modulator pressure buildup	Current supply to term.18	Press button HA. Switch on both dynamometer rollers. Actuate brake pedal and hold 2000 N constant. Press illuminated key.	Reading of brake dynamometer moves to left to an intermediate value and rises again to HL: 1000...1100 N	H01
22	Hydraulic modulator pump delivery rate	Current supply to term.18	Switch on both dynamometer rollers. Read off intrinsic friction factor. Press button HA. Actuate brake pedal and hold 2000 N constant.	After an intermediate value at both sides, return supply pump is briefly switched on. Reading must fall at both sides below intrinsic friction factor plus max. 200 N.	H03

Take for road test for final check. With the engine running, the warning lamp must go out.
Drive at at least 30 km/h. The warning lamp must not light up again.

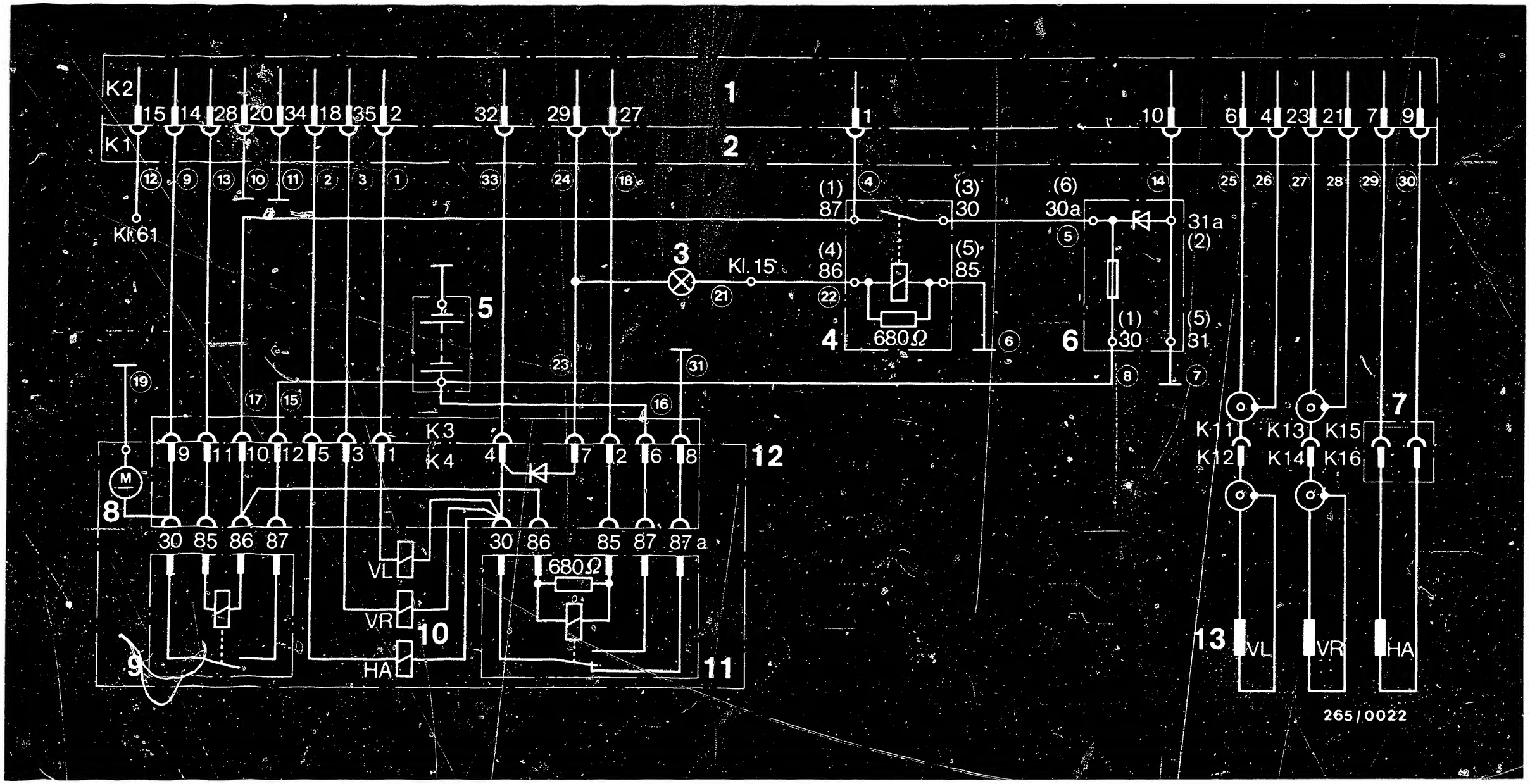
A17 — <==> A18 — <==

TEST SPECIFICATIONS

Testing of the ABS should be done only with the ABS tester for reasons of safety.

The test program contains all important test specifications as well as information on testing and replacing components.

For production reasons:
continued on the following coordinate.



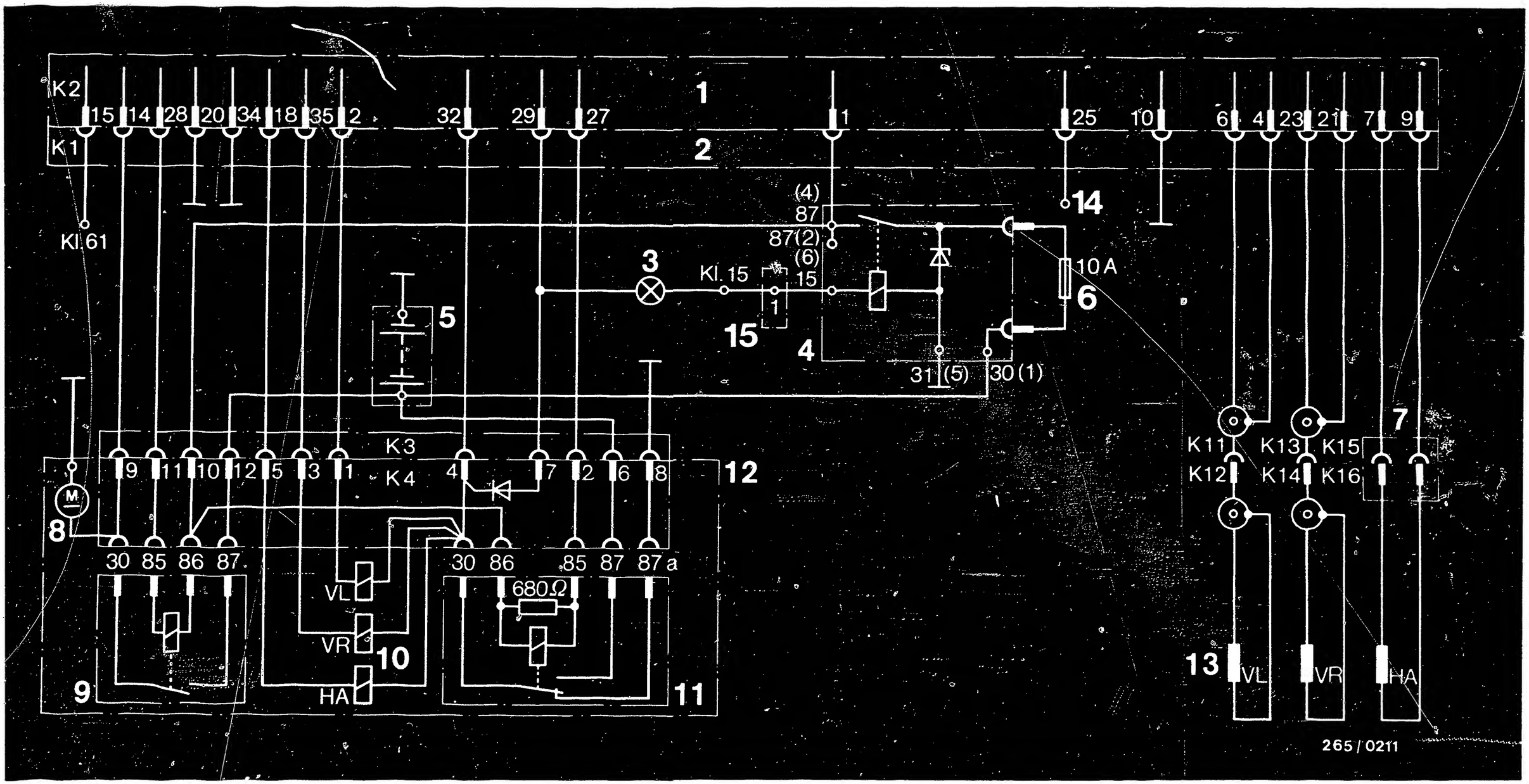
1 = Controller
2 = Controller plug (35-pin)
3 = ABS warning lamp
4 = Relay for controller
5 = Battery
6 = Over-voltage protection
7 = Multiple butt connector
8 = Return-pump motor
9 = Motor relay
10 = Solenoid-operated valves
11 = Valve relay
12 = Hydraulic modulator
13 = Wheel-speed sensors

l = VL = Left front
r = VR = Right front
h = HA = Rear axle
Terms 1 to 16 = ABS plug connections
Numbers in circuit = Lead numbers

ELECTRICAL TERMINAL DIAGRAM FOR MERCEDES BENZ TYPES 107/116/123/126 (UNTIL 9.81)

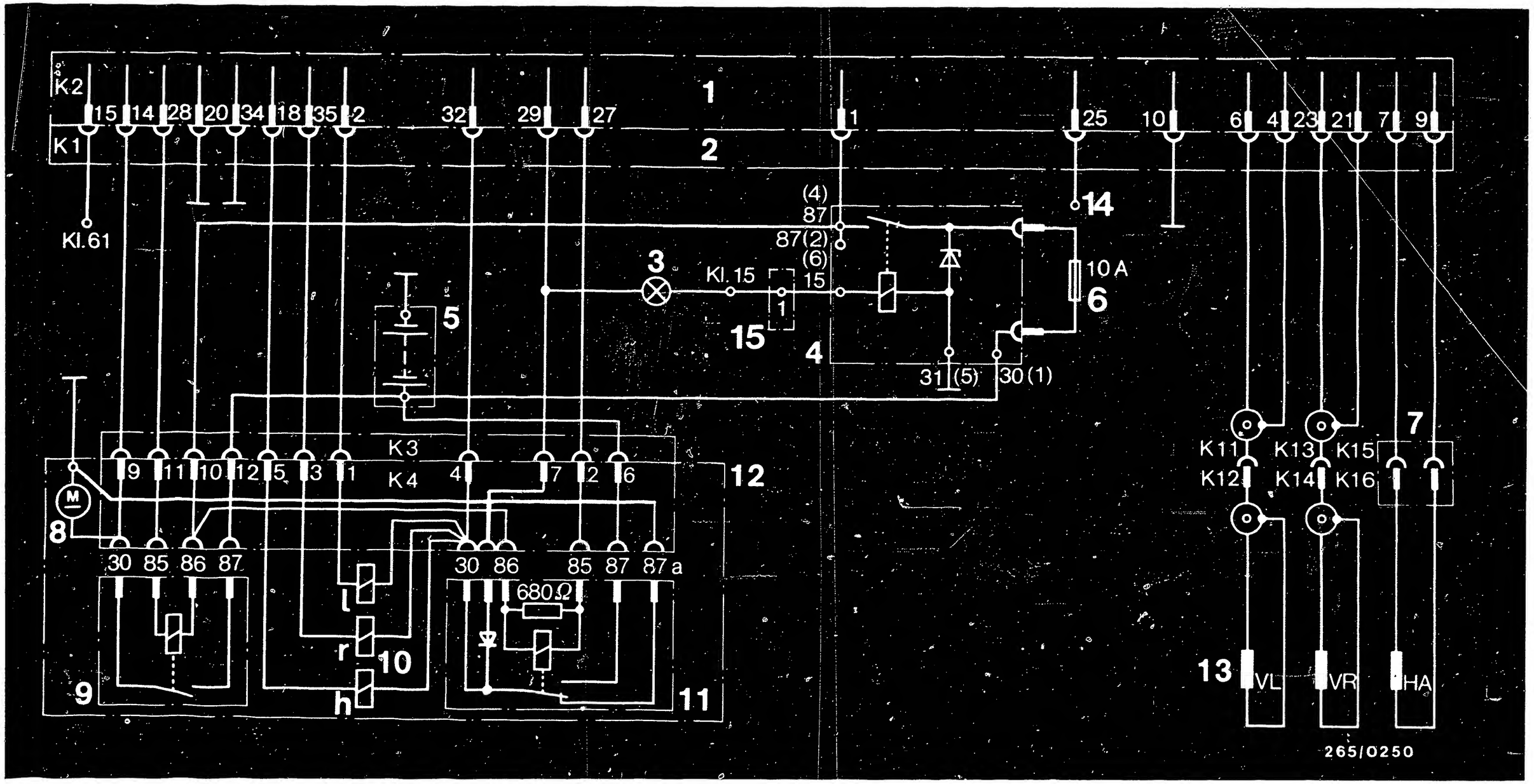
| A21 | — | ⟹ |

| A22 | — | ⟺ |



1 = Controller
2 = Controller plug (35-pin)
3 = ABS warning lamp
4 = Over-voltage protection relay
5 = Battery
6 = Plug-in fuse
7 = Multiple butt connector
8 = Return-pump motor
9 = Motor relay
10 = Solenoid-operated valves
11 = Valve relay
12 = Hydraulic modulator
13 = Wheel-speed sensors
14 = To stop-lamp switch (+)
15 = Plug connection, 12-pin (only W 124)
l = Left front
r = Right front
h = Rear axle
Terms 1 to 16 = ABS plug connections

ELECTRICAL TERMINAL DIAGRAM FOR MERCEDES-BENZ TYPES 107/116/123/126 (9.81->8.85)
(Conversion to take place gradually).



1 = Controller
2 = Controller plug (35-pin)
3 = ABS warning lamp
4 = Over-voltage protection relay
5 = Battery
6 = Plug-in fuse 10 A
7 = Multiple butt connector
8 = Return-pump motor
9 = Motor relay
10 = Solenoid-operated valves
11 = Valve relay
12 = Hydraulic modulator
13 = Wheel-speed sensor
14 = To stop-lamp switch (+) Terms. 1 to 16 = ABS plug connections
15 = Plug connection, 12-pin (only W 124)
l = Left front
r = Right front
h = Rear axle

ELECTRICAL TERMINAL DIAGRAM FOR ALL MERCEDES-BENZ VEHICLES (AS OF 8.85) (Conversion to take place gradually).

TEST EQUIPMENT AND TOOLS

Description	Designation	Part number
ABS tester Use converted testers only! Identification mark "U2" on nameplate or as of FD 352	ETT 016.00	0 684 101 600
Brake dynamometer	e.g. BPS 100 or BPS 101 or BPS 104 or BPS 105	0 680 012 .. 0 680 013 .. 0 680 018 .. 0 680 019 ..
Charging and bleeding device		e.g. ATE Part no.3.9302-1000.4 1)
Bleeder connection for connecting the charging and bleeding device to the fluid reservoir of the master cylinder		ATE Part no. 3.9302.0702.2 1)
Bleeder hose		ATE Part no. 3.3590.2300.1 1)
Auxiliary hose		ATE Part no. 3.9302.0704.2 1)
Brake-pedal actuating device		ATE Part no. 3.9312.0100.4 1)

1) = obtainable from: Alfred Teves GmbH
Guerickestraße 7
D-6000 Frankfurt / Main

2) = obtainable from: Firma H a z e t
D-5630 Remscheid

TEST EQUIPMENT AND TOOLS (CONTINUED)

Description	Designation	Part number
Pressure tester Tester for low and high pressure testing of hydraulc brake systems		e.g. ATE Part no.3.9305-0200.4 1)
Double-end flare nut wrench 9 x 11 mm		Hazet Part no. 612 2)
Vessel for catching the brake fluid, approx. 1 l		
Brake fluid: Use ATE Original Brake Fluid DOT 4 or Mercedes-Benz brake fluid only!		
Electrics tester or Multimeter for trouble-shooting	ETE 014.00	0 684 101 400 Commercially available
Grease for wheel-speed sensors		Molykote Longterm 2
Protective caps for brake lines		1 900 508 002 (100 pieces)
Protective caps for brake-line connections to hydraulic modulator		1 900 508 004 (100 pieces)
		DB Part no.
Wear indicator, front axle left		126 540 03 09
Wear indicator, front axle right		126 540 02 09
Cable clip		000 546 10 43
Washer-and-screw assembly		914 004 006 001
Use original brake lines from Mercedes-Benz only		

INSTALLATION POSITION OF COMPONENTS

Installation position information is always given with reference to the direction of travel.

* ABS warning lamp:
In the instrument panel.

* Front-axle wheel-speed sensors:
One each on left and right in the steering knuckles.

* Rear-axle wheel-speed sensor:
One on rear-axle housing (below the rear seat).

* Hydraulic modulator:
In the engine compartment on the left in front of the brake master cylinder.

* Ground terminal for ABS:
Types 107 and 116:
  Behind the right footwell panel.
Types 123 and 126:
  Behind the instrument panel, to the right of the steering column.

* Controller:

Type 107:
  Behind the right footwell support.
Type 116/123:
  Behind the right footwell panel.
Type 126:
  In the equipment space between the windshield-wiper motor.

* Relay for controller:

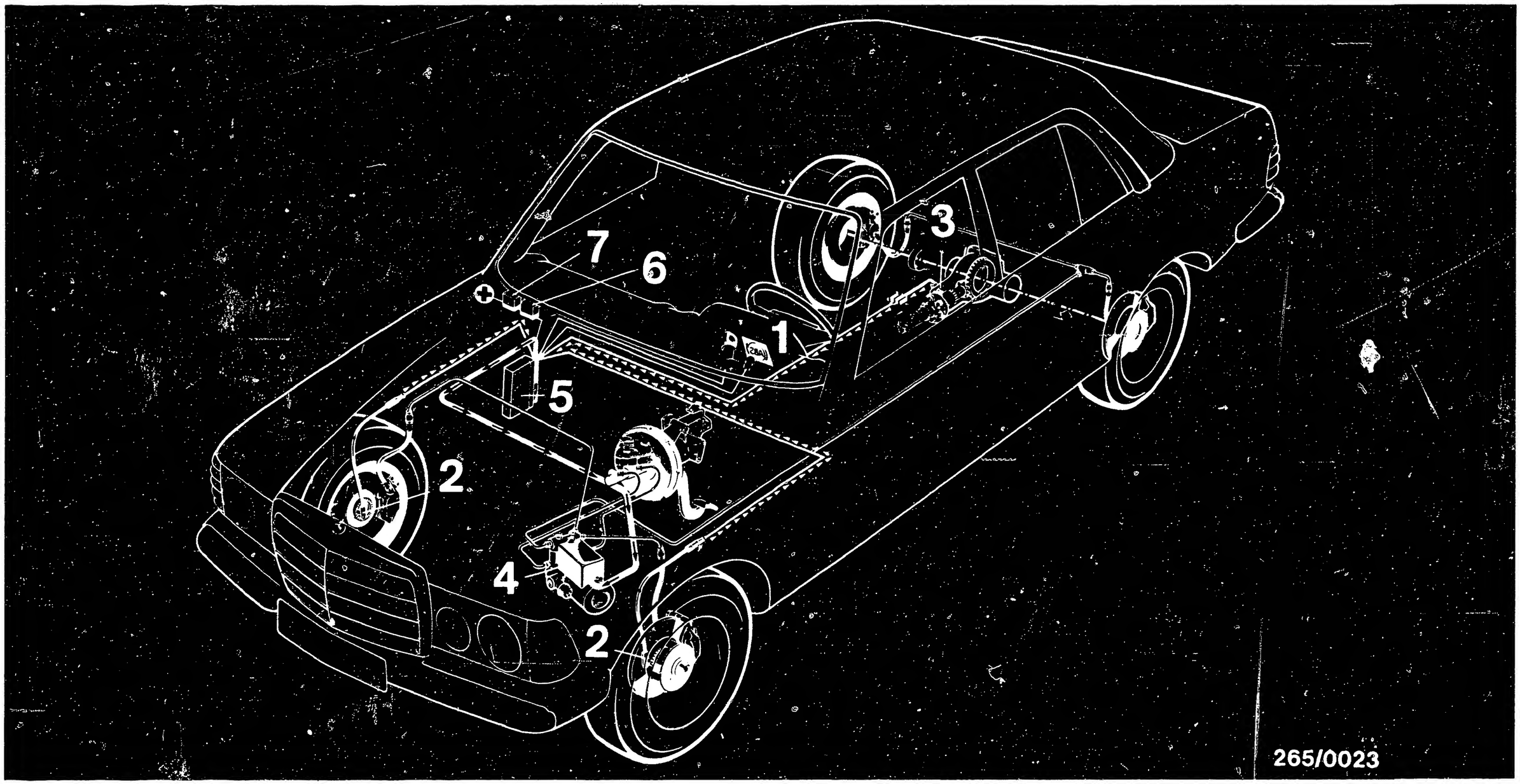
Type 107:
  Behind the right footwell panel.
Type 116:
  Underneath the glove compartment.
Type 123:
  Behind the glove-compartment panel.
Type 126:
  In the fuse box in the equipment space.

* Over-voltage protection:

Type 107:
  Behind the right footwell panel.
Type 116:
  Behind the right footwell panel next to the controller.
Type 123:
  Behind the glove-compartment panel.
Type 126:
  In the fuse box in the equipment space.

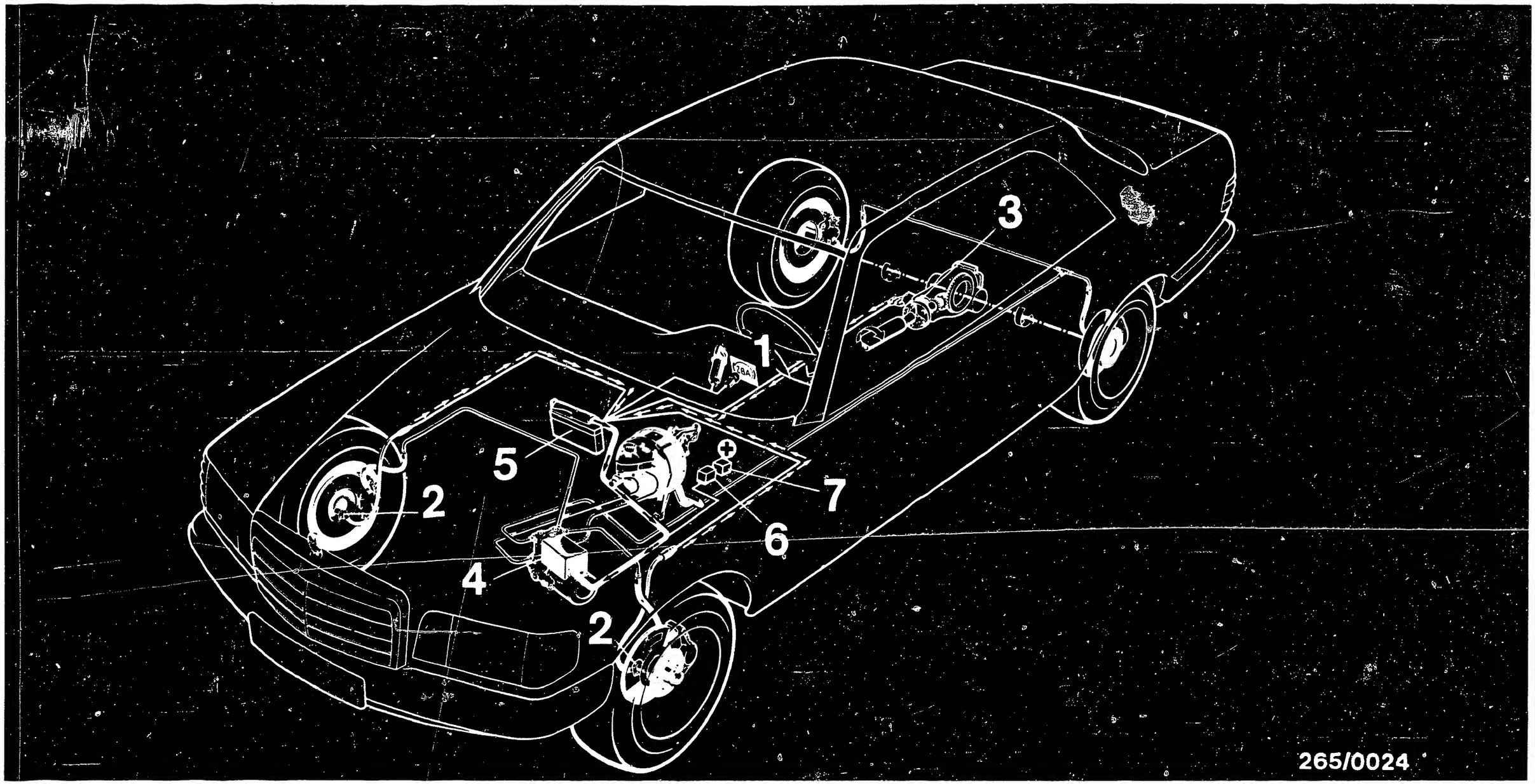
* Over-voltage protection relay:

Type 107 / 116 / 123 / 126:
  Gradually integrated in the fuse box on all types starting in 8.85.



1 = ABS warning lamp
2 = Front-axle wheel-speed sensors
3 = Rear-axle wheel-speed sensor
4 = Hydraulic modulator
5 = Controller
6 = Relay for controller
7 = Over-voltage protection relay

INSTALLATION POSITION OF COMPONENTS IN TYPES 200 D - 280 E (W 123, W 116 similar)



1 = ABS warning lamp
2 = Front-axle wheel-speed sensors
3 = Rear-axle wheel-speed sensor
4 = Hydraulic modulator
5 = Controller
6 = Relay for controller
7 = Over-voltage protection relay

INSTALLATION POSITION OF COMPONENTS IN VEHICLES OF THE "S-CLASS" (W 126)

BLEEDING BRAKING SYSTEM

After replacing the hydraulic modulator, it is necessary to bleed the braking system and carry out a high- and low-pressure test.

Exercise caution when working with brake fluid!

a) Brake fluid should be kept only in containers with which there is no possibility of accidental drinking (C a u t i o n , p o i s o n !)

b) Even very slight traces of mineral oil will lead to malfunctioning of the braking system. It is particularly important to be careful when working with clear or yellow brake fluid, since the danger of mistaking one for the other is particularly acute. If mineral oil is located or suspected in the braking system, the entire braking system must be thoroughly rinsed with brake fluid. In addition, the main cylinder must be replaced.

c) Do not allow brake fluid to come into contact with the vehicles's finish, since brake fluid contains components which act as paint solvents.

d) Brake fluid is very hygroscopic, i.e. it absorbs moisture from the air, resulting in a lowering of its boiling point. For this reason, brake fluid must be stored in well-sealed storage containers.

Note:

In the course of vehicle operation the boiling point of the brake fluid is lowered due to continuous absorption of moisture from the atmosphere.
This can cause formation of vapor pockets in the braking system during heavy braking.
For this reason, the brake fluid must changed once yearly, in spring if possible.

Bleeding

* When bleeding with a braking-system bleeder device, observe the operating instructions provided by the manufacturer. In order to remove all air bubbles from the tandem master cylinder, during the bleeding process the brake pedal must be fully depressed at least three times with the bleeder screw open.

* When bleeding by "pumping" the brake pedal, close the corresponding bleeder screw each time before the brake pedal is returned, so that no air is sucked in through the threads of the bleeder screw.

* Slowly return the brake pedal so that sufficient brake fluid is suctioned out of the fluid reservoir by the return stroke of the piston.

* Bleeding is completed when clear, bubble-free brake fluid comes out of the bleeder hose.

I m p o r t a n t !
The brake fluid pumped out during bleeding must not be re-used, since it can contain foreign objects which would in this way re-enter the braking system.

* Fill the fluid reservoir with brake fluid up to the "Maximum" mark.

CHECKING THE BRAKE SYSTEM FOR LEAKS

	High-pressure test	Low-pressure test
Line test pressure gauge pressure	50 ... 90 bar	3 bar
Test duration	5 minutes	2 minutes
Pressure drop of set value	5 % (max.)	0 %

Note:

The leakage check, which must be performed in both brake circuits, comprises high-pressure and low-pressure testing.

High-pressure test

Connect pressure tester to a fixed caliper. To do this, unscrew bleeder screw and screw in fitting. Then bleed pressure tester.

* Allow engine to run at medium speed and generate as high a vacuum as possible by suddenly releasing the accelerator pedal.

* Using the brake-pedal actuating device depress the brake pedal until a line pressure of between 50 and 90 bar gauge pressure is generated. Then hold brake in this position.

* During the test period of 5 minutes, the pressure drop may not be greater than 5% of the set value. If the pressure drop is greater than this figure, the leak (brake master cylinder, brake hoses, brake lines, brake calipers) must be sought and eliminated, or the hydraulic modulator must be replaced.

Low-pressure test

* Release the brake-pedal actuating device until a line pressure of 3 bar gauge pressure is indicated on the press. gauge.

* During a test period of 2 minutes, the set pressure must not drop. If the pressure drop is greater than this figure, the leak must be sought and eliminated, and the brake master cylinder or the hydraulic modulator must be replaced.

GENERAL INFORMATION

with regard to repair work and the braking system

The ABS is basically maintenance-free; however, when working on vehicles with ABS the following must be taken into account:

1. The plug must be disconnected from the electronic controller prior to welding work with an electric welder.

2. For painting, the electronic controller may be briefly subjected to a maximum temperature of 95° C, and for longer periods (approx. 2 hours) a maximum of 85° C

3. After replacing the hydraulic modulator, the controller, the wheel-speed sensors, and the wiring harness, as well as after work in which the ABS assemblies are affected (e.g. after accidents), the entire ABS system must be inspected using the tester. Correct routing of the brake lines is vital.

4. After all work on the braking system, it must be bled, and a low- and high-pressure test must be carried out. All connection points must be checked for leakage.

5. If the battery has been removed, after re-installation the battery terminals must be securely tightened to the terminal posts of the battery.

6. No fast chargers may be used to start the engine.

7. Never disconnect the battery from the vehicle electrical system with the engine running.

8. When boost-charging the battery, disconnect it from the vehicle electrical system.

9. Make sure all plug connections of the wiring harness are correctly seated.

10. Never disconnect or connect the wiring-harness plug of the controller while the ignition is on.

11. For reasons of safety, the hydraulic modulator must not be repaired, but may only be completely replaced.

    The engine and valve relays are an exception. Both relays may be replaced.

    With the exception of the brake-line connections, no screws on the hydraulic modulator may be loosened.

    After loosening, it is impossible to re-establish sealing of the brake circuits.

    This can be f a t a l !

OPERATION OF ABS WARNING LAMP

Vehicles equipped with ABS come into the workshop with one of the following customer complaints:

* Warning lamp not lighting up after switching on the ignition.

* Warning lamp n o t going out after reaching a vehicle speed of above 6 km/h (previously) or after reaching idle speed (new).

* Warning lamp lighting up again when driving or lighting up occasionally.

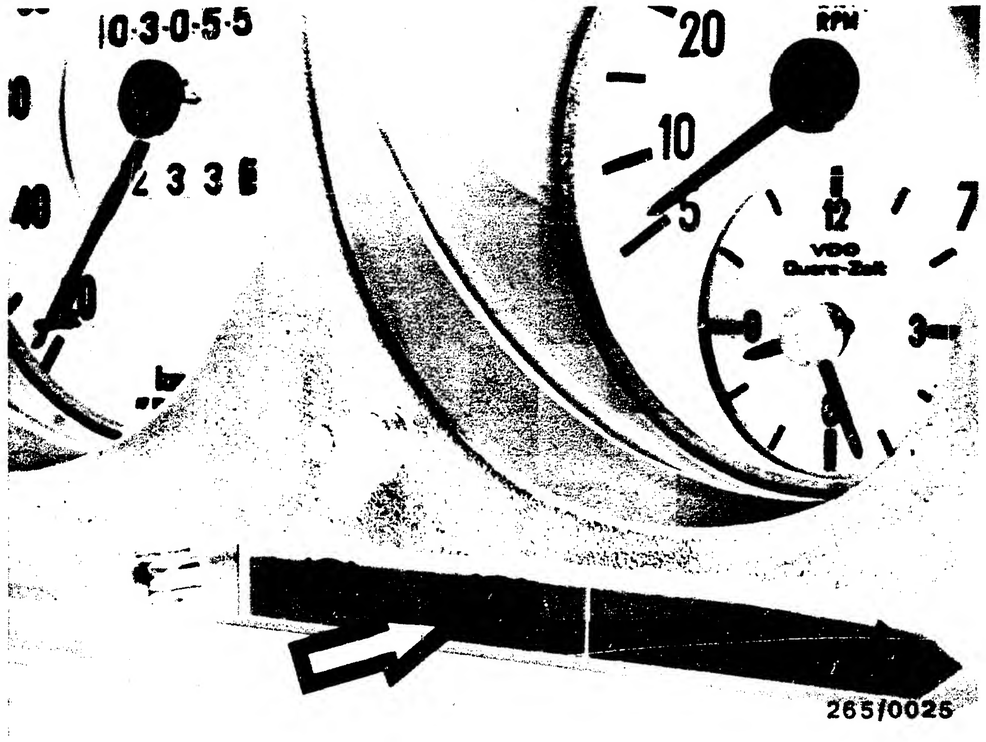
Confirm the complaint yourself before checking entire ABS system with the ABS tester.

For reasons of safety, the ABS may only be checked using the ABS tester.

The ignition must always be switched off for connecting the ABS tester as well as when connecting or disconnected the controller.

If you have detected a fault with the ABS tester, always disconnect the controller before performing further trouble-shooting.

In the following, you are informed of the correct function and malfunction of the ABS warning lamp.



1 = ABS warning lamp in instrument panel

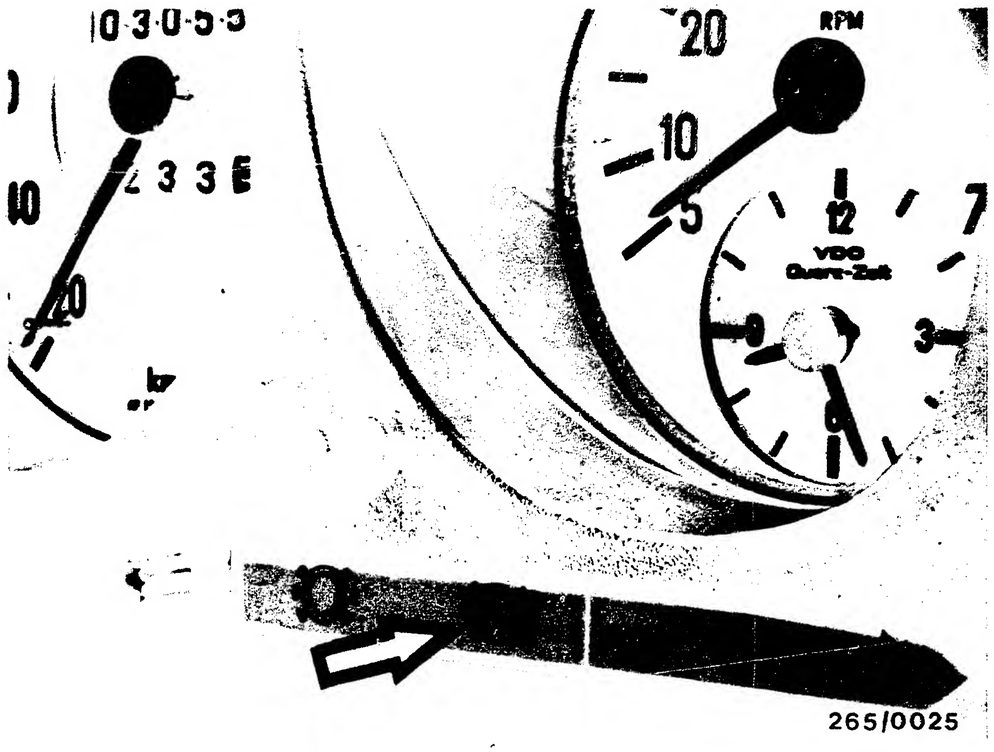
ABS warning lamp (previous operation)

When the ignition is switched on, the warning lamp marked with the letters "ABS" lights up.

When the vehicle reaches a speed of 6 km/h/4 mph (with all 4 wheels), the warning lamp goes out.
This process is repeated every time the ignition is switched off and back on.

If the ABS system is defective, the warning lamp lights up and remains lit, signalling to the driver that the ABS is not operating.

The normal brakes remain operable.



1 = ABS warning lamp in instrument panel

ABS warning lamp (new)

When the ignition is switched on, the warning lamp designated with the letters "ABS" lights up.

After starting and reaching the engine idle speed, the ABS warning lamp goes out (terminal 61 of the alternator supplies voltage to the ABS controller).

When the vehicle exceeds a speed of approx. 6 km/h/4 mph with all four wheels for the first time after starting, the ABS system carries out a self-check (BITE run).

This procedure is repeated every time the ignition is switched off and the vehicle is then re-started.

In addition, the ABS continually monitors itself within a certain range of functions during travel.

If the ABS system is defective, the warning lamp lights up and stays lit at the latest after vehicle speed exceeds 12 km/h/8 mph (at 12 km/h/ 8 mph the wheel-speed sensor voltages are checked.)

Continuous illumination of the warning lamp indicates to the driver that the ABS is switched off.

The normal brakes remain operable.

Faulty warning-lamp indications are:

* The warning lamp fails to light up after the ignition is switched on.

* The warning lamp fails to go out after idle speed is reached.

* The warning lamp comes back on during driving or comes on occasionally. (ABS switch switched on!)

The illumination of the ABS warning lamp indicates to the driver that the ABS is not operable.

Nevertheless, the regular brake system can be used for braking.
However, blocking of the wheels is a possibility.
This is truth both in case of defect as well as when the ABS is switched off using the ABS switch.

The causes of defects can be determined with the help of the ABS-tester and a brake test stand.

General note:
Occasional illumination of the warning lamp can be caused by an inadequately-charged battery.
The lamp lights up only so long as the under-voltage exists, i.e. after switching on current-consuming devices during idling.

For production reasons:
continued on the following
coordinate.

ABS TESTER

The ABS tester tests functioning of the controller, the hydraulic modulator, the wiring harness, and the components of the antilock braking system (ABS).

With the ABS tester, actual values are found which are compared with the appropriate nominal values.

If the actual-value reading deviates from the prescribed nominal value, trouble-shooting should be carried out in accordance with the information in the "trouble-shooting" column.

The ABS tester should be connected between the controller and the ABS wiring harness (before connecting the tester, switch off the ignition).

Do not drive with the ABS tester connected!

The test steps are set with the program switch (1 through 24).

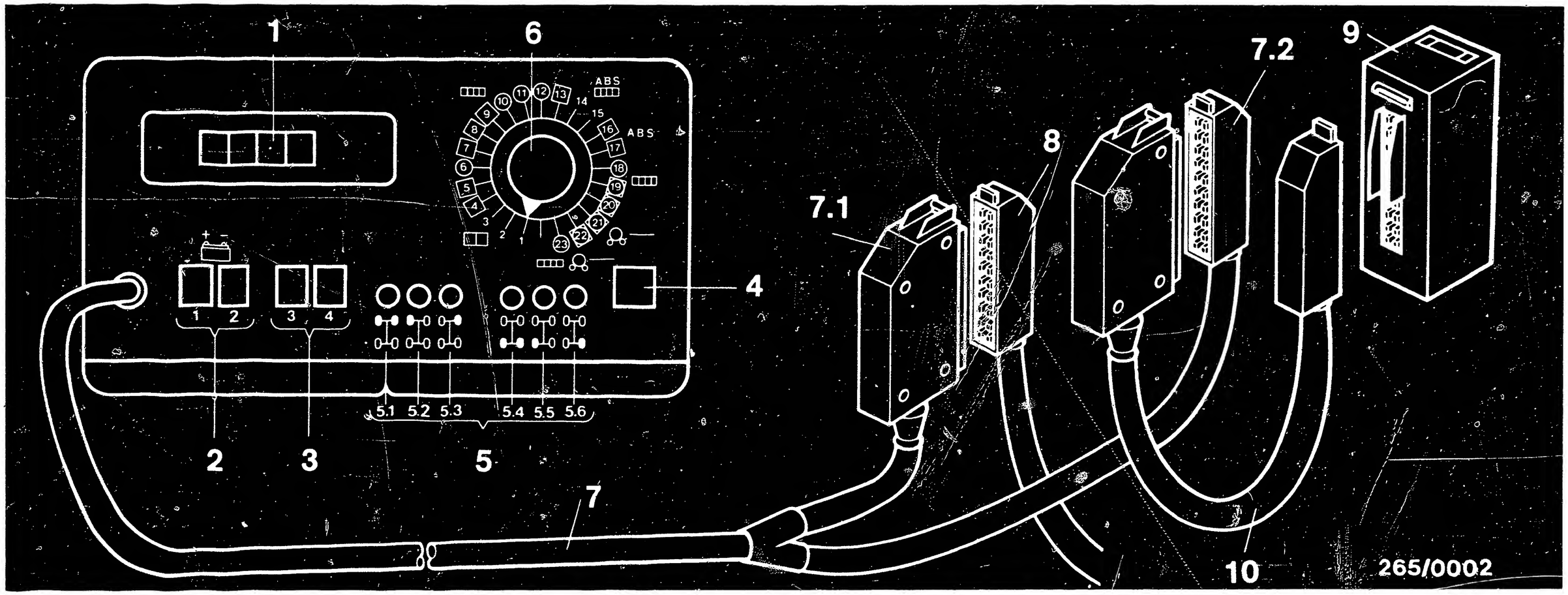
With the wheel-speed sensors and the hydraulic modulator, the round buttons should be pressed according to the test chart.

Test steps requiring large amounts of current are initiated only after the illuminated button is pressed. The illuminated button lights up automatically in the appropriate test steps.

The actual value is indicated either by the green-red lamps or the digital display.

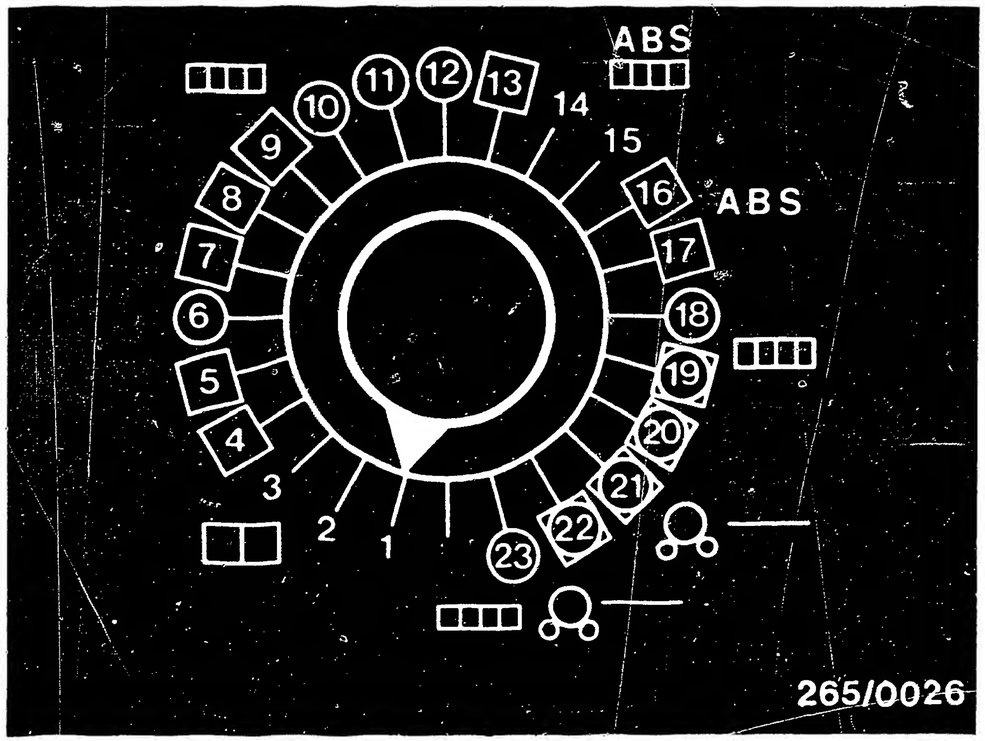
The test steps requiring program-switch positions 20...23 can be carried out only on a dynamic brake analyzer.

For Generation 2 B the ABS tester must be converted.



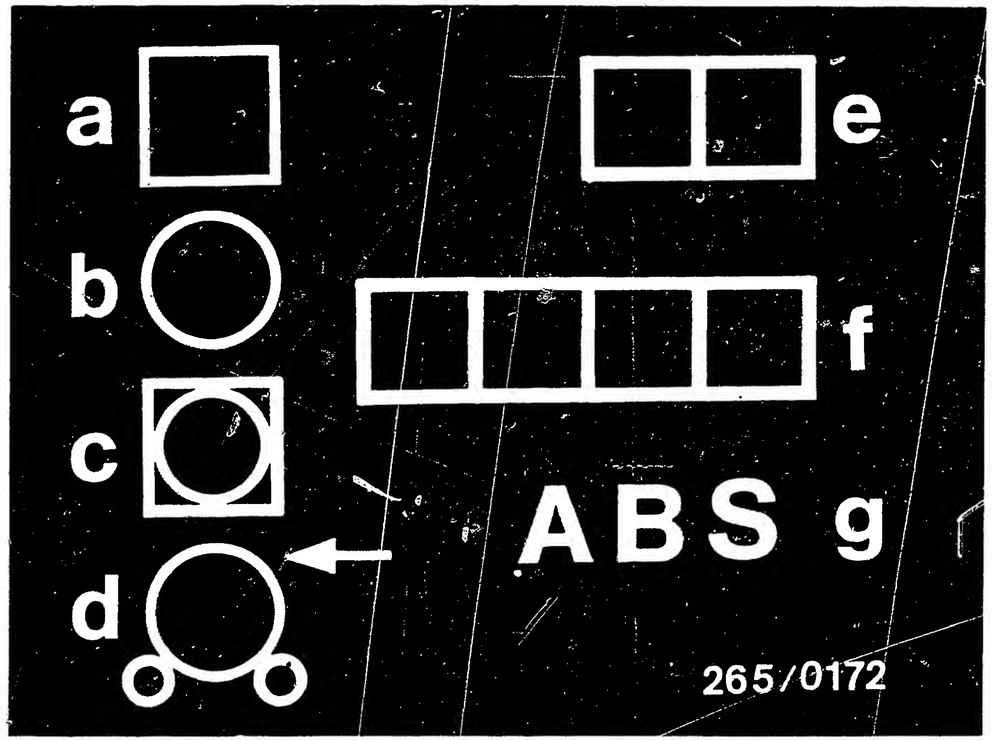
1 = Digital LED display unit
2 = Lamp 1 (green): battery voltage O.K.
Lamp 2 (red): battery voltage too low
3 = Lamp 3 (green): motor relay and valve relay as well as overvoltage protection O.K.
Lamp 4 (red): motor relay and valve relay as well as overvoltage protection defective
4 = Illuminated key (yellow) for triggering individual test steps
5 = Channel selection key (wheel selection)
5.1 = Front axle (VA)
5.2 = Wheel, front left (VL)
5.3 = Wheel, front right (VR)
5.4 = Rear axle (HA)
5.5 = Wheel, rear left (HL)
5.6 = Wheel, rear right (HR)
6 = Program-selector switch
7 = Connecting cable
7.1 = Connection to wiring harness
7.2 = Connection to controller
8 = Controller plug of vehicle wiring harness
9 = ABS controller (installed in vehicle)
10 = Mechanically encoded adapter cable for 4-channel controller

ABS TESTER (CONTINUED)



Program switch (description of symbols)

Program switch for 24 program steps



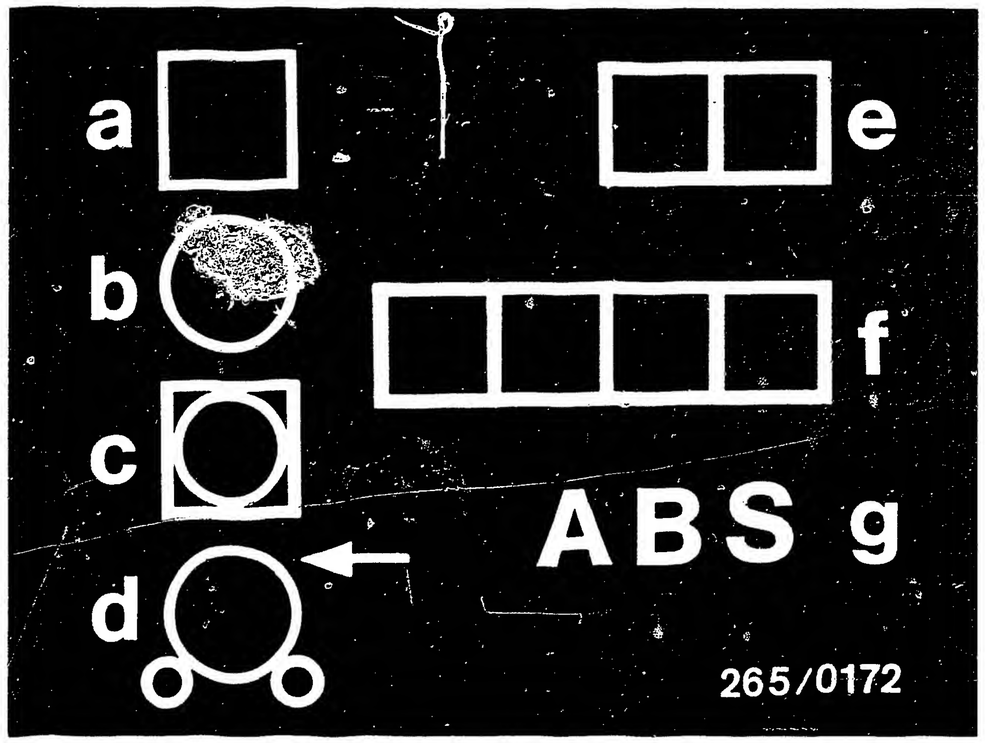
a = Press illuminated button (pos. 4)

b = Press appropriate buttons for circuit selection (pos. 5.1 through 5.6)

c = Press button for circuit selection (pos. 5.1 through 5.6). Press illuminated button (pos. 4)

d = Drive vehicle onto dynamic brake analyzer first with front and then with rear axle.

Symbols for additional operation

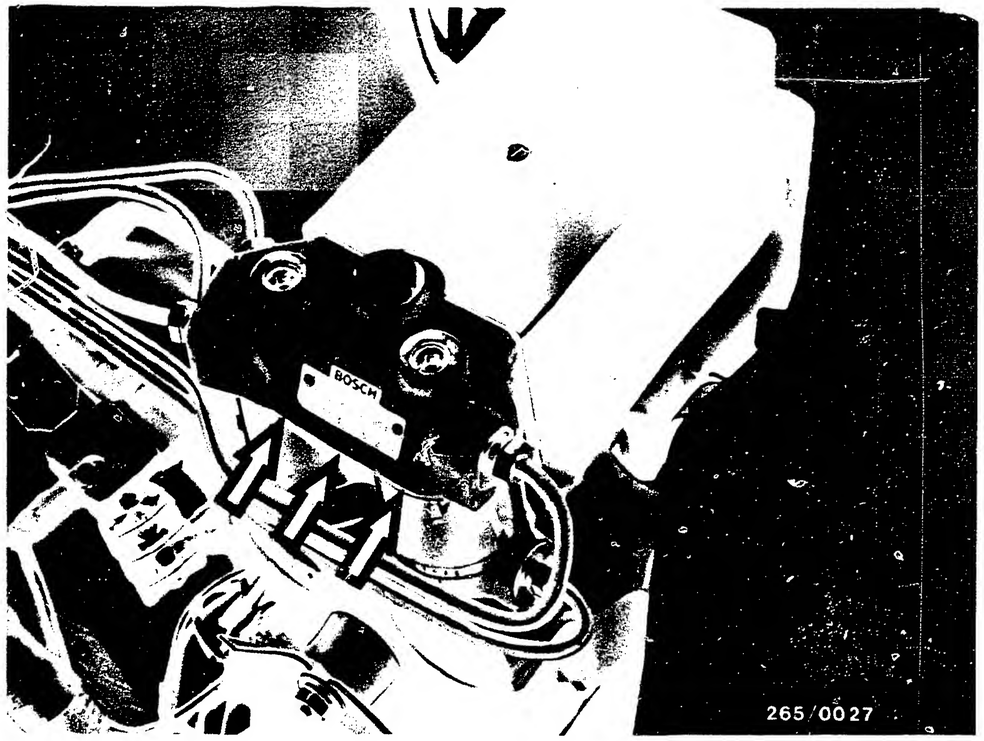


e = Red-green display,
Lamp units (pos. 2 or 3)

f = Digital display (pos. 1)

g = Note warning lamp in vehicle!

For production reasons:
continued on the following
coordinate.



REQUIREMENTS FOR TESTING

Testing with the ABS tester

* Check return-pump ground connection for secure seating.

* Check hydraulic connections at hydraulic accumulator for leakage (visual inspection).
  Pay particular attention to sealing points (arrows).

* If the ABS warning lamp temporarily lights up during travel (e.g. after switching on consuming devices) and then goes out again by itself, check the battery and voltage supply (generator, regulator, and voltage drop).

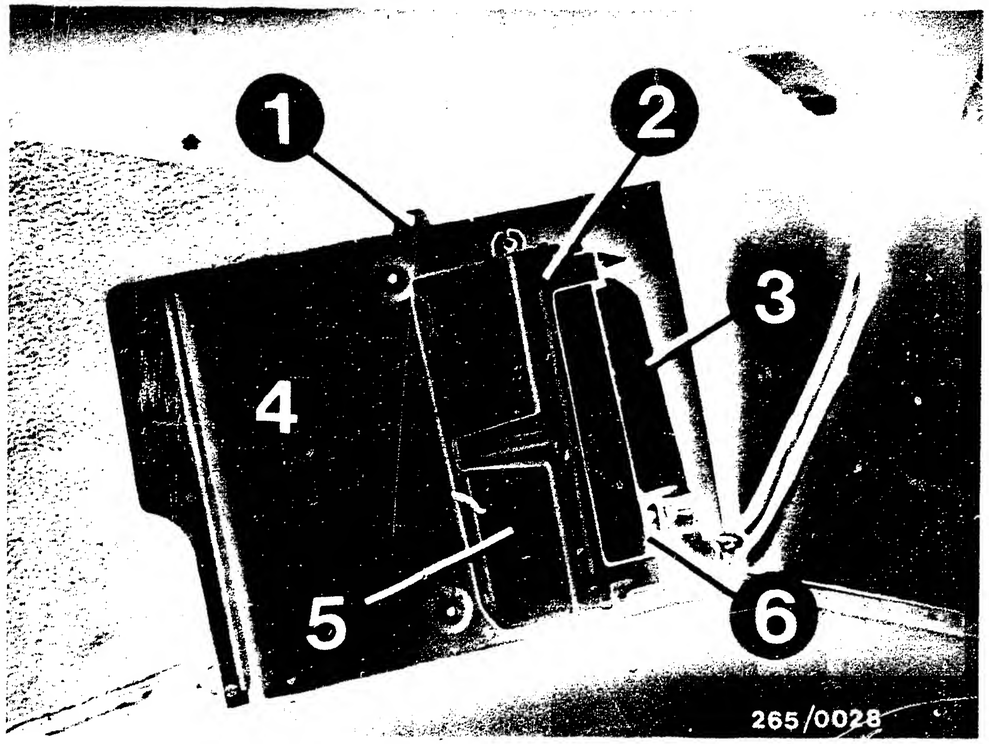
* If the ABS warning lamp lights up and does not go out, check the following points:

-> Does the multiple plug on the controller show correct seating and is it engaged?
Are all plug connections OK?
Are spring connections engaged?

-> Is V-belt torn?
(Generator provides no voltage, charge and ABS warning lamps light up).

-> Does generator term. 61 provide voltage?
Plug connection and lead to ABS controller OK.

-> In program-switch position 10, pay particular attention to checking for loose contacts for the wheel-speed sensors.



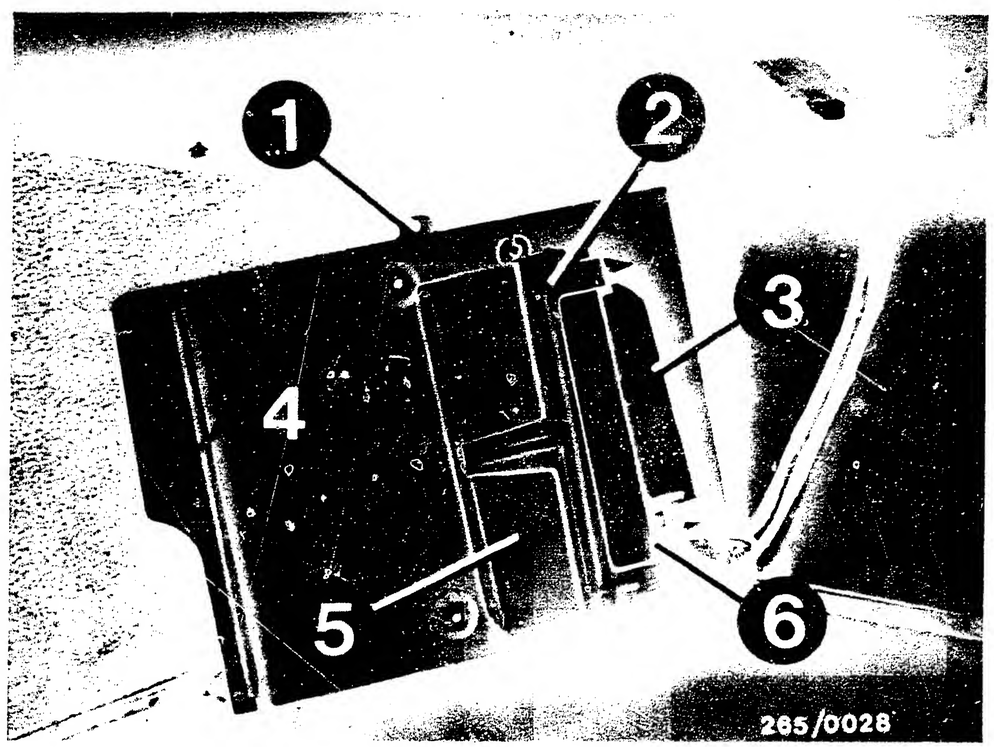
1 = Fastening screw
2 = Holder
3 = Plug (35-pin)
4 = Footwell cover plate
5 = Controller
6 = Detent (spring)

* Connect the ABS-tester between the controller and the ABS wiring harness.

Careful!
Unplug and plug the controller only with the ignition switched off.

Connection of the ABS-tester on Type 107

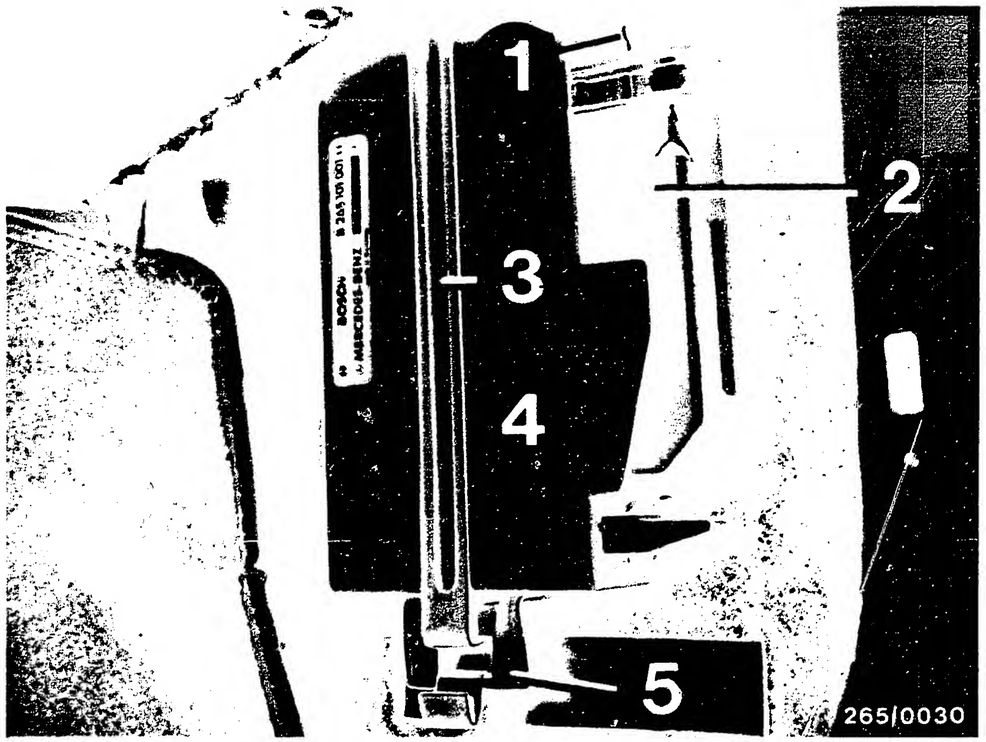
The installation position is located behind the right footwell support.



Unscrew the footwell support and expose the controller.

Unscrew the controller from the plate (1).

Swing up the plug (3) after pushing back the spring (6) and remove.



Connection of the ABS-tester on Types 116 and 123

The controller is located behind the right footwell panel on the passenger's side.

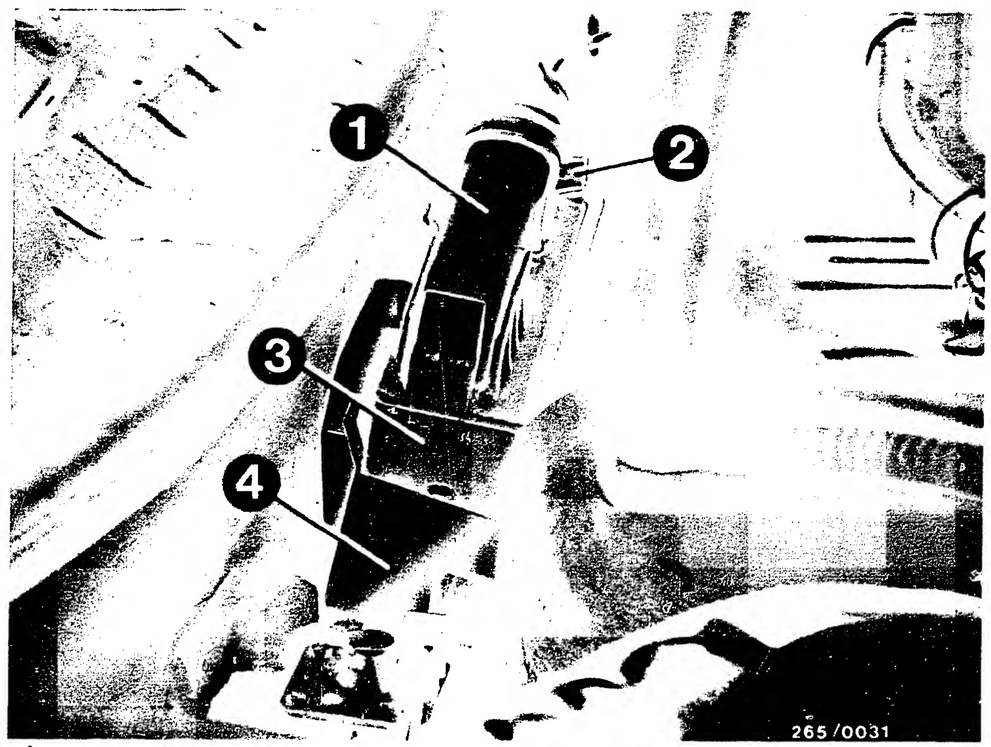
Remove the air-duct grille on the side panel.

Unscrew the panel fastening screw and remove the panel.

Lift the bracket (3) on the lower end slightly and pull out of the holder (5).

Remove the electronic controller (4) from the holder (5).

Swing up the plug (2) after pushing back the spring (1), and remove.



Connection of the ABS-tester on Type 126

The controller (3) is located in the equipment space between the windshield wiper and air filter.

Remove any plug covering that may be present and take the controller out of the holder (4).

Swing up the plug (1) after pushing back the spring (2), and remove.

* For testing with the tester, switch on the ignition in all program-switch positions (the tester gets its current supply from the car battery).

* Observe tester lamps 1 and 2 in all program-switch positions.

I M P O R T A N T !

Do not drive with the tester connected!

The entire test program must be repeated after every repair.

General note on trouble-shooting:

Test all leads for ground connection and contact with positive leads, as well as watching out for abrasion and pinching.

TEST CHART FOR ABS TESTER

N o t e :

In the following test steps, the boxed-in texts indicate which operation is different from that of the preceding test step.

TEST STEP 1 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:

Monitoring of voltage supply for controller in all program-switch positions.
This test step must be taken into account during all following test steps, i.e. lamps 1 and 2 must be observed during the entire testing process.

Operation:
Program-switch positions
1 through 24

Operation in vehicle:
Switch on ignition

Test specifications (reading):
Lamp 1 (green) must light up and stay lit.

Note:
Lamp 1 (green) = OK
Lamp 2 (red) = defect
Occasional illumination of lamp 2 (red) = defect

1. Is reading present?
2. Does green lamp 1 light up and stay lit?

N>

Trouble-shooting:

Before unplugging the controller, switch off the ignition. If necessary use circuit diagram.

1. No display:
* Controller plug not correctly plugged in.
* Plug-in fuse in over-voltage protection relay defective.
* Fuse for term. 15 defective
* Over-voltage protection relay defective.
* Controller relay defective.

Test the following leads:

* Positive lead from B+ to over-voltage protection relay or over-voltage protection term. 30.

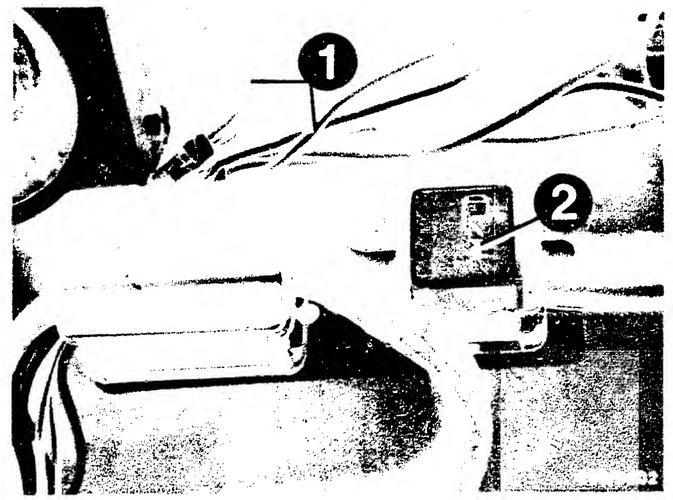
* Negative lead from over-voltage protection term. 31 or over-voltage protection relay term. 31 and relay for controller.
Term. 85 to ground terminal on Types 107 and 116 is behind the right footwell panel. On Types 123 and 126, behind the instrument panel to the right of the steering column.

V

Continued on next coordinate

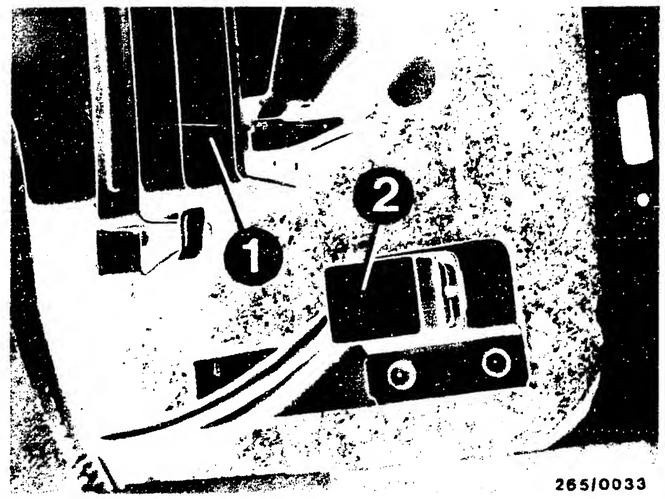
V

Continued on next coordinate



Installation position in Type 116
1 = Ground terminal
2 = Relay for controller

1 = Controller
2 = Over-voltage protection



TEST STEP 1 (CONTINUED) (TEST SPECIFICATIONS AND OPERATING INSTRUCTIONS)

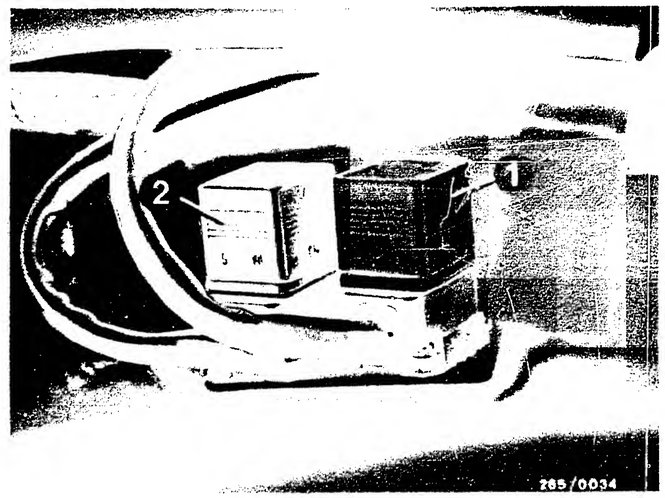
* Negative lead from over-voltage protection term. 31a (if present) to controller plug term. 10.

* Ground terminals must be bare metal and have no contact resistance.

* Positive lead from over-voltage protection term. 30a to relay for controller term. 30.

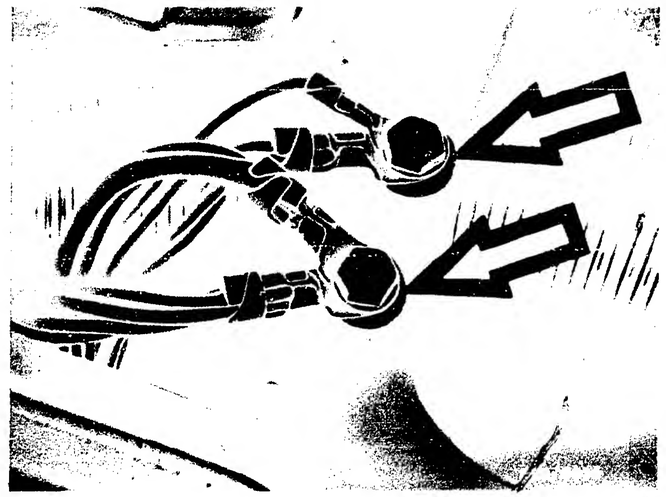
* Positive lead from relay for controller term. 87 or from over-voltage protection relay term. 87 to controller plug term. 1.

* Positive lead from relay for controller term. 86 or over-voltage protection relay term. 86 to driving switch term. 15.



1 = Relay for controller
2 = Over-voltage protection

Arrows = Ground terminals



Continued on next coordinate

Continued on next coordinate

2. Lamp 2 (red) lights up
or lights up briefly during testing process:
Interrupt testing and eliminate source of trouble

Sources of trouble:

1. Battery insufficiently charged.
Charge battery or let engine run.

2. Excessive voltage drops at ground terminals:
Ground terminals must be bare metal.

After eliminating faults, carry out complete test program.

1 = Relay for controller
2 = Over-voltage protection

Arrows = Ground terminals

Continued on next coordinate

V

Component/Function:

Valve relay – contact in inoperated position

Operation:
Program-switch position 1

Operation in vehicle:

Switch on ignition.

Test specification (reading):

Lamp 1 (green) and lamp 3 (green) must light up.

Do lamps 1 and 3 light up?

N>

Trouble-shooting:
(Switch off ignition)

Lamp 4 (red) lights up:

* Valve relay defective.
  Careful!
  Use only relays with correct electrical terminal assignment.

* Ground connection has excessive contact resistance or open circuit.

* Check the following leads for continuity:

  – From ground to plug K3/term. 8.

  – From plug K3/term. 8 to valve relay term. 87a.

  – As of 9.85, from ground to return-pump motor ground.

  – From return-pump motor ground to valve relay term. 87a.

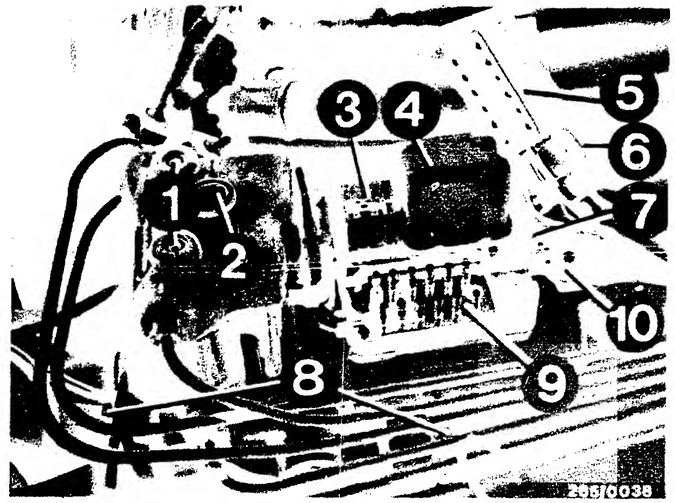
  – From K4/term. 4 to valve-relay plug term. 30.

  – From K3/term. 4 to controller plug K1/term. 32

Y

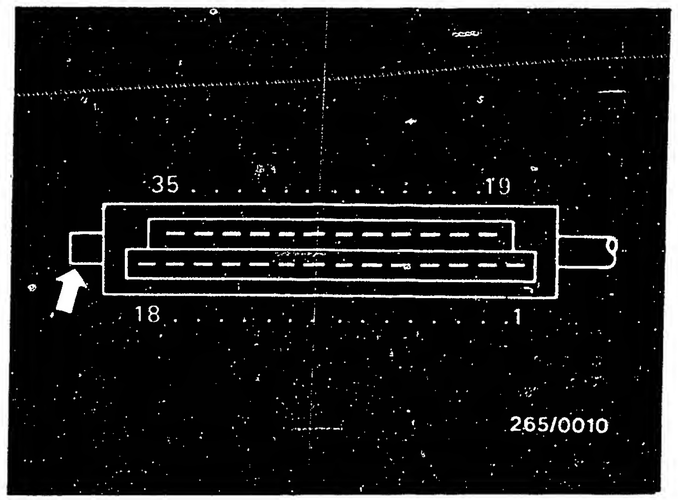
V

Continued on next coordinate



3 = Valve relay
5 = Plug (K3)
7 = Ground lead
9 = Plug base (K4)

Top view of controller plug K1 (35-pin)



TEST STEP 3 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Valve relay – normally-open contact | N>

Operation:
Program-switch position | 2

Operation in vehicle:
Switch on ignition

Test specification (reading):
Lamp 1 (green) and
lamp 3 (green) must light up.

Do lamps 1 and 3 light up?

Y

V

Continued on next coordinate

Trouble-shooting
(switch off ignition):

Lamp 4 (red) lights up:

* Valve relay defective.
  Caution!
  Only insert relay with
  correct electrical terminal
  allocation.

* Check following leads
  for continuity:

  From term. B+ to
  plug K3/term. 6.

  From K4/term. 6 to valve
  relay term.87.

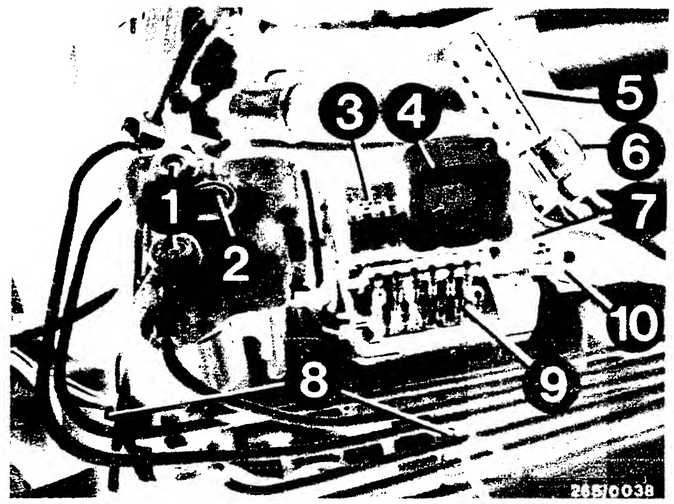
  From K3/term. 2 to controller
  plug K1/term. 27.

  From K4/term. 2 to valve
  relay term.85.

  From valve relay term. 86
  to engine relay term.86.

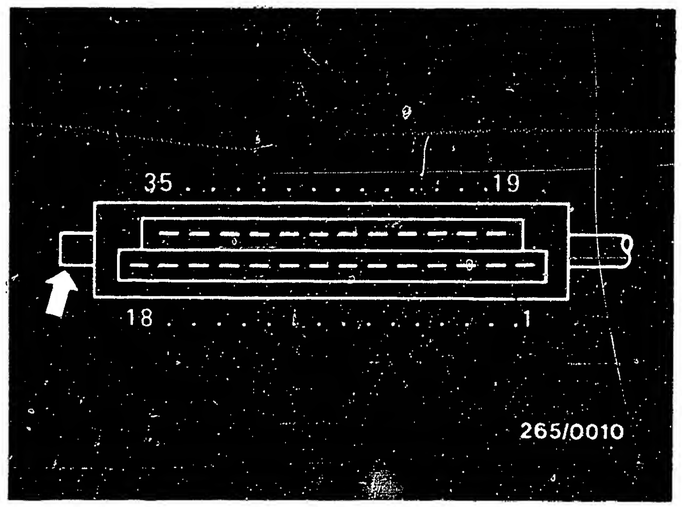
  From engine relay term.86
  to K4/term. 2.

  From 10/term. K3 to transition
  protection relay term.10
  or relay for controller
  term.87.



3 = Valve relay
4 = Motor relay
5 = Plug (K3)
9 = Plug base (K4)

Top view of controller plug
K1 (35-pin)



TEST STEP 4 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Motor relay – contact in inoperated position

N>

Operation:
Program-switch position 3

Operation in vehicle:
Switch on ignition

Test specification (reading):
Lamp 1 (green) and lamp 3 (green) must light up.

Do lamps 1 and 3 light up?

Y

V

Continued on next coordinate

Trouble-shooting
(Switch off ignition)

Lamp 4 (red) lights up:

* Motor relay defective.

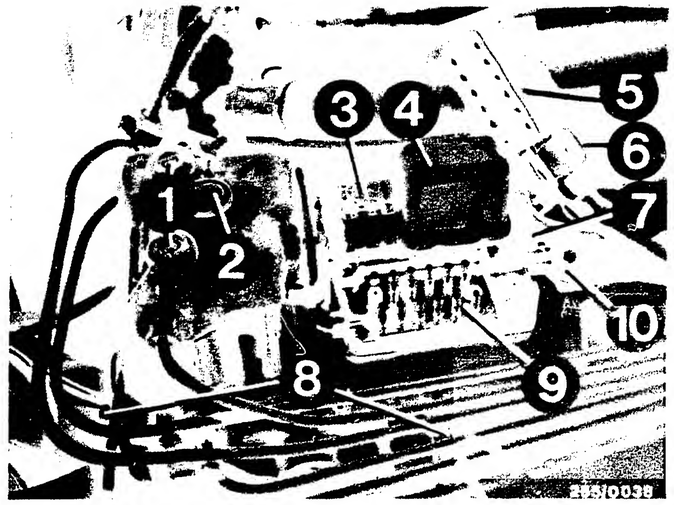
* Check pump-motor ground terminals for firm seating and contact resistance.

* Test following leads for continuity:

  From multiple plug K1/term.14 to plug K3/term.9.

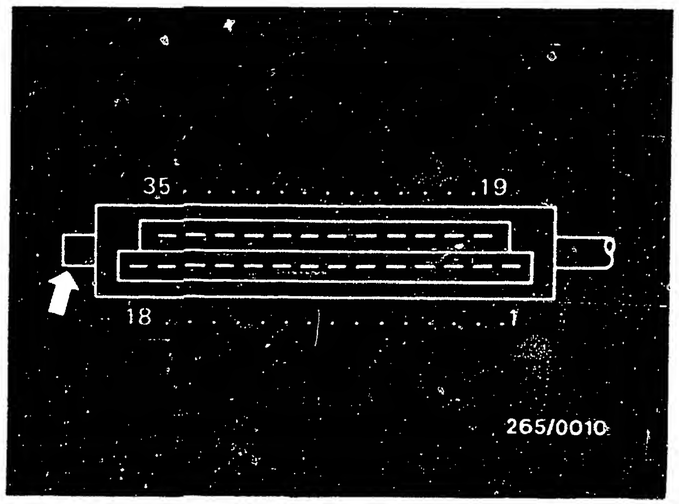
  From K4/term.9 to engine relay term. 30 and to the pump-motor positive connection.

* Test pump-motor positive connection for firm seating. Test pump motor for continuity. If no continuity is measurable, continue testing with test step 5.



4 = Motor relay
5 = Plug (K3)
7 = Ground lead
9 = Plug base (K4)
10 = Positive connection

Top view of controller plug K1 (35-pin)



TEST STEP 5 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Motor relay – normally-open contact

N>

Operation: 4
Program-switch position illuminated button lights up, press button.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
Lamp 1 (green) and lamp 3 (green) must light up.

Do lamps 1 and 3 light up ?

Trouble-shooting
(Switch off ignition).

Lamp 4 (red) lights up:

*Motor relay defective.

*Test following leads for continuity:

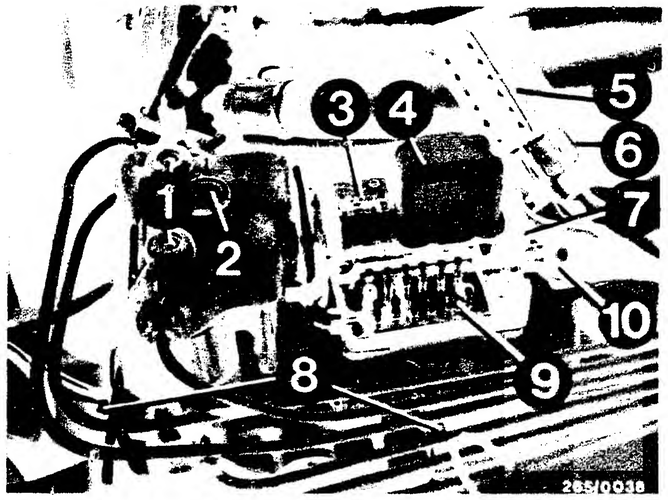
From motor relay term. 85 to K4/term. 11.

From K3/term. 11 to multiple plug K1/term. 28.

From motor relay term. 87 to K4/term. 12.

From K3/term. 12 to term. B+.

*Pump motor not running : Continue testing with test step 6.



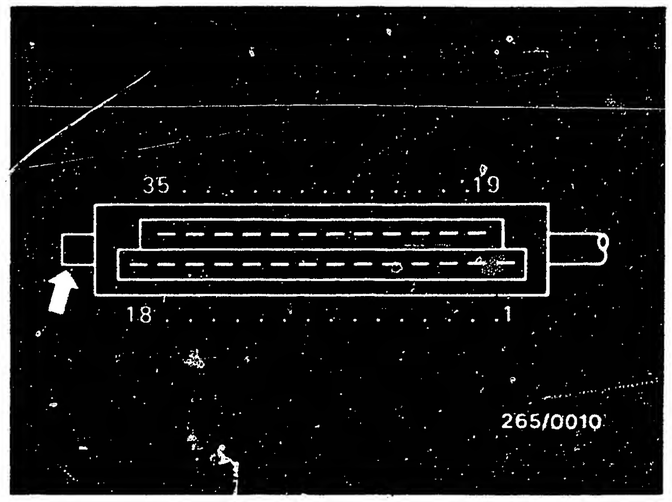
4 = Motor relay
5 = Plug (K3)
9 = Plug base (K4)
10 = Positive connection

Y

V

Continued on next coordinate

Top view of controller plug K1 (35-pin)



TEST STEP 6 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/function:
Testing with tester applies only to 4-pin over-voltage protection until approx. 8.85. Over-voltage protection relay (installed fuse and Zener diode only).
For testing of the 5-pin over-voltage protection relay, see before trouble-shooting.

N>

Operation:
Program-switch position: 5

Switch off ignition and disconnect controller.
Plug over-voltage protection (until 9.81) or over-voltage protection relay (until 8.85) of vehicle into test socket on rear of tester.
Plug new over-voltage protection or over-voltage protection relay in vehicle.

Operation in vehicle:
Switch on ignition and wait approx. 1 s, then press illuminated button (lights up).

Test specifications (reading):
Lamp 1 (green) and
Lamp 3 (green) must light up.

Do lamps 1 and 3 light up?

Y

V

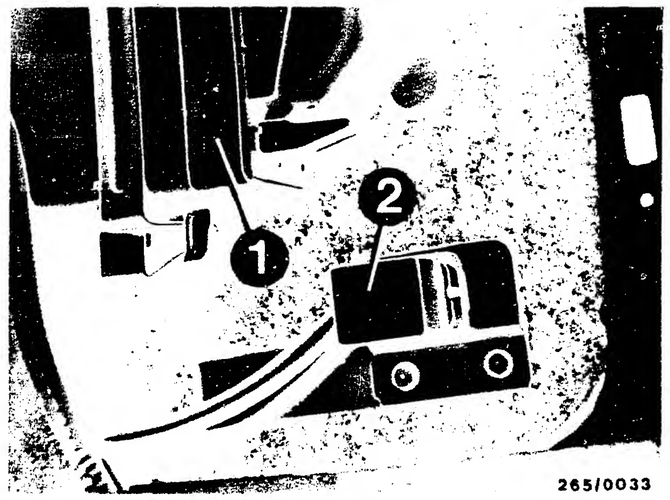
Continued on next coordinate

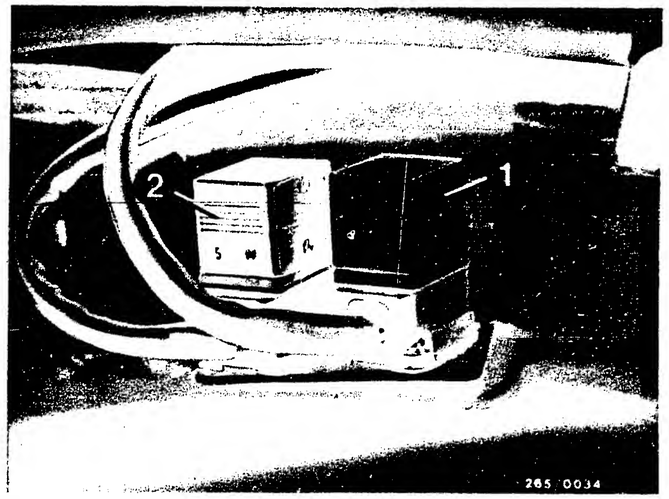
Testing of the 5-pin over-voltage protection relay as of approx. 8.85. Testing with tester does not apply. Test Zener diode by way of replacement with ohmmeter in both conducting and reverse directions.

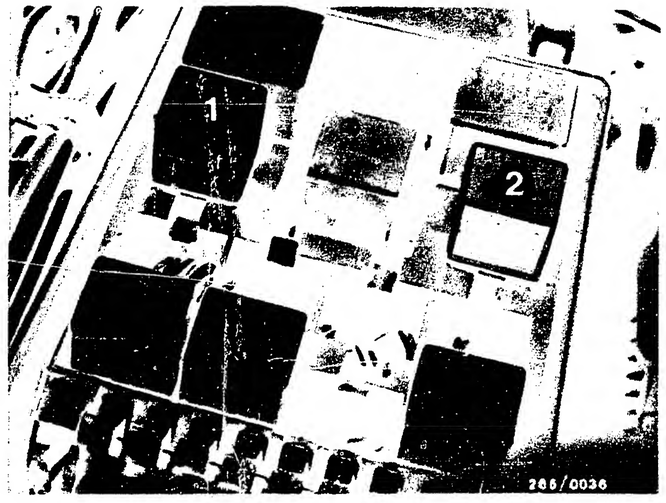
Trouble-shooting:
1. Correct (identical type) relay plugged in vehicle?
2. Repeat test step.
3. The over-voltage protection or protection relay plugged into the tester is defective.

Note:
Upper illustration:
Over-voltage protection
Item 2 Type 116
Middle illustration:
Over-voltage protection
Item 2 Type 123
Lower illustration:
Over-voltage protection
Item 2 Type 126
Not illustrated:
Over-voltage protection
Item 2 Type 107
Behind the right footwell panel.
Not illustrated:
Over-voltage protection relay.

Types 107/116/123/126:
Gradually being integrated in fuse box in all types.







V

Component/function:
Hydraulic modulator.
Internal resistance of solenoid valves.

N>

Operation:
Program-switch position: 6

Press following keys consecutively and read off digital reading after pressing each key.

1. Press key VL
2. Press key VR
3. Press key HA

Operation in vehicle:
Switch on ignition.

Test specification (reading):
1. VL: 0,7...1,7 Ω
2. VR: 0,7...1,7 Ω
3. HA: 0,7...1,7 Ω

Are measured values within the test-specification tolerance?

Y

Continued C27

Trouble-shooting:
(Switch off ignition)

1. Measure internal resistance directly at hydraulic modulator:

   * Valve VL between K4/term. 1 and K4/term. 4
   * Valve VR between K4/term. 3 and K4/term. 4
   * Valve HA between K4/term. 5 and K4/term. 4

Set value not obtained:
Replace hydraulic modulator.

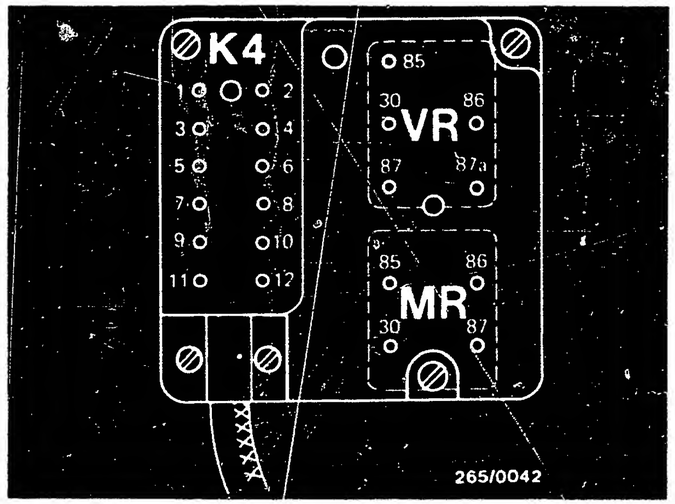
2. Check leads for continuity (set value 0 Ω):

   * Valve VL between K3/term. 1 and controller plug K1/term. 2
   * Valve VR between K3/term. 3 and controller plug K1/term. 35
   * Valve HA between K3/term. 5 and controller plug K1/term. 18

If open circuit:
* Check plug-in connections.
* Eliminate open circuit.

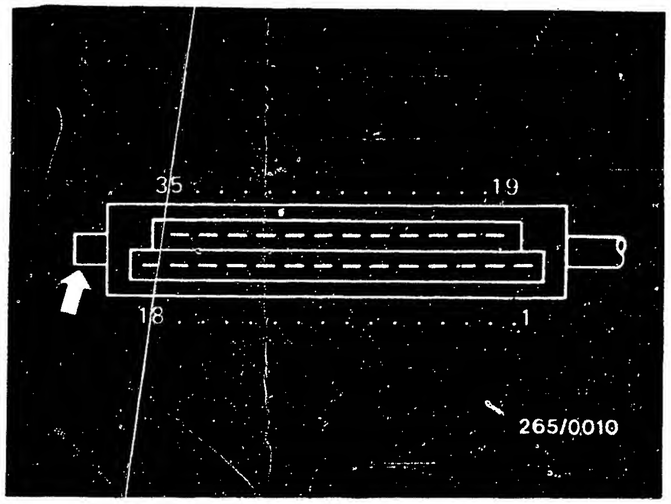
V

Continued on next coordinate



Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug

Top view of controller plug K1 (35-pin) with terminal numbers
Arrow = Mechanically-coded lug



Removing the hydraulic modulator

* For safety reasons, the hydraulic modulator must not be repaired, but the complete unit must be replaced.

  Exceptions to this are the motor relay and the valve relay. Both relays may be replaced.

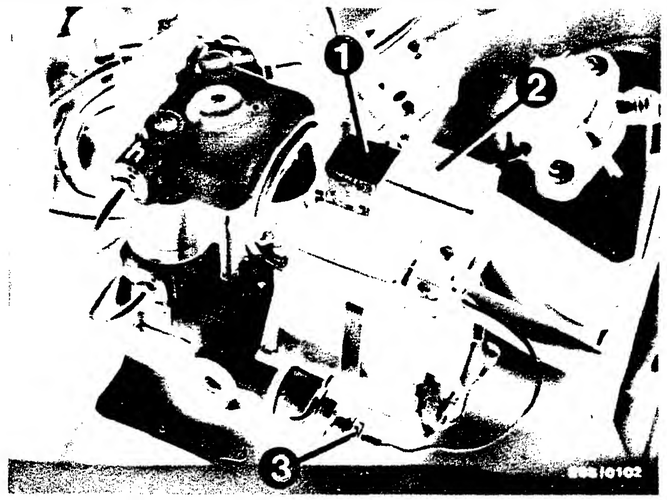
* Apart from the brake-line connections, it is not permissible to loosen any screws on the hydraulic modulator.

  In particular, the hexagon-socket-head cap screws may under no circumstances be loosened.

  After loosening, it is no longer possible to get the brake circuits leak-tight.
  D a n g e r!

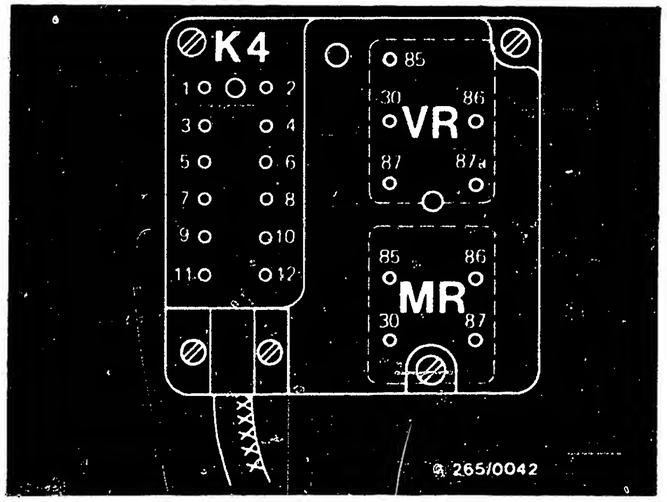
* Check the hydraulic modulator and brake-line connections for leaks by means of a visual examination.

  If brake fluid is escaping, tighten the brake-line connections (12...16 Nm) or replace, or replace the hydraulic modulator.



1 = Valve relay
2 = Motor relay
3 = Ground terminal

Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug



Pay particular attention to the joint identified by the arrows (upper illustration).

On the base of the hydraulic modulator there is a vent hole to the pump pistons.

A slight escape of brake fluid is possible at this point.

A complaint is only justified if, after pressing the brake pedal several times, a pool of brake fluid is formed under the hydraulic modulator.

* When removing and installing the brake lines, make sure that the lines are marked in accordance with the markings on the hydraulic modulator and that they are not mixed up when re-connecting (e.g. VL of hydraulic modulator must be connected to the front left wheel brake cylinder).

* Markings on hydraulic modulator:

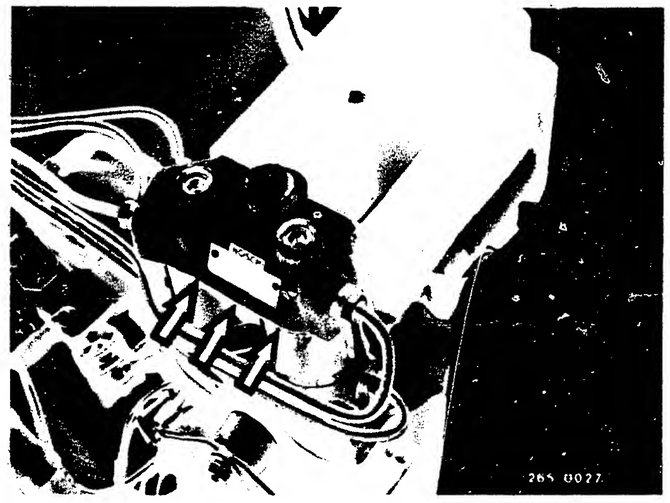
V = Front-axle brake circuit of staged tandem brake master cylinder

H = Rear-axle brake circuit of staged tandem brake master cylinder

l = Lead to wheel brake cylinder, front left

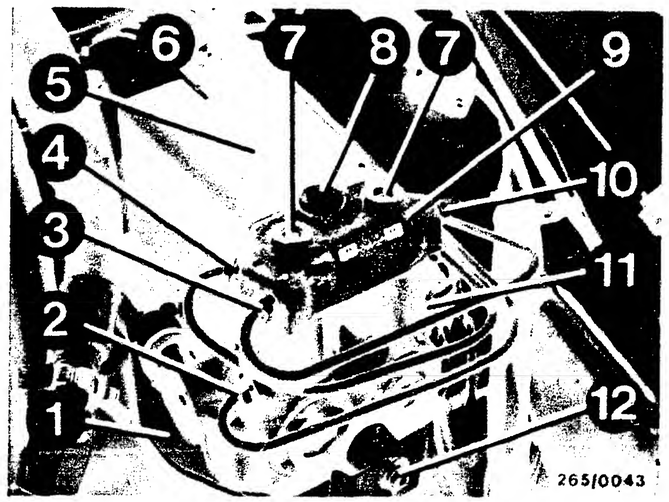
r = Lead to wheel brake cylinder, front right

h = Lead to the rear wheel brake cylinders.



Arrows = Sealing points

2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line



* Use only the specified double-end flare nut wrench 9 x 11 mm for loosening and tightening the brake lines.

* Mark brake lines and loosen from hydraulic modulator.

* Catch the brake fluid and do not bring it into contact with your skin or clothing or with paintwork!

* Immediately seal the brake lines and connections with dummy plugs.

* Disconnect ground cable (7) from pump motor.

* Loosen fastening screw and remove cover.

* Loosen bracket (6) and remove plug (5).

* Loosen hexagon nuts (8) and remove hydraulic modulator.

Installation

* Mount hydraulic modulator in the holder and fasten with the hexagon nuts.

* Connect ground cable to pump motor.
Plug on 12-pin plug (5) and fasten with the bracket (6).

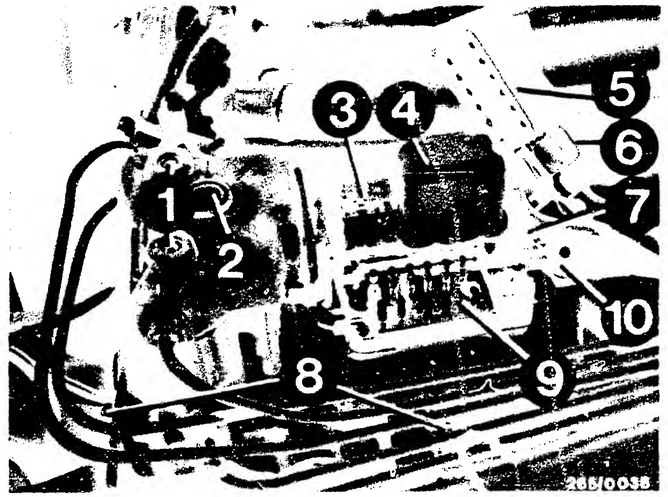
* Fasten cover on the hydraulic modulator with the screw.

* Connect the brake lines to the hydraulic modulator in accordance with the markings.

* Observe the tightening torque for the brake-line connections on the hydraulic modulator: 12...16Nm.

* Bleed the brake system and check for leaks.

* Fully test the ABS with the tester.



5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)

TEST STEP 8 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Ground connection terminal term.10 N>
Contact resistance.

Operation:
Program-switch position: 7

Illuminated button lights up, press button.

Operation in vehicle:
Switch off ignition.

Test specification (reading):
110...300 mV

Is the measured value within the tolerance range ?

Y

V

Continued on next coordinate

Trouble-shooting
(switch off ignition)

1. Reading less than 10 mV:
   Have the tester inspected.

2. Reading greater than 300 mV:
   Test the ground terminal for excessive contact resistance.

Test lead for open circuit:

* Until 9.81, from ground through over-voltage protection terms. 31 and 31a to controller plug K1/term. 10.

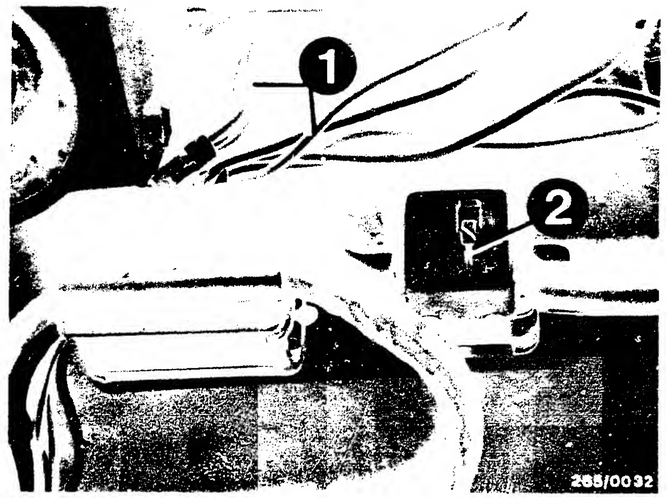
* As of 9.81, from controller plug K1/term. 10 to ground and from term. 31 of the over-voltage protection relay to ground.

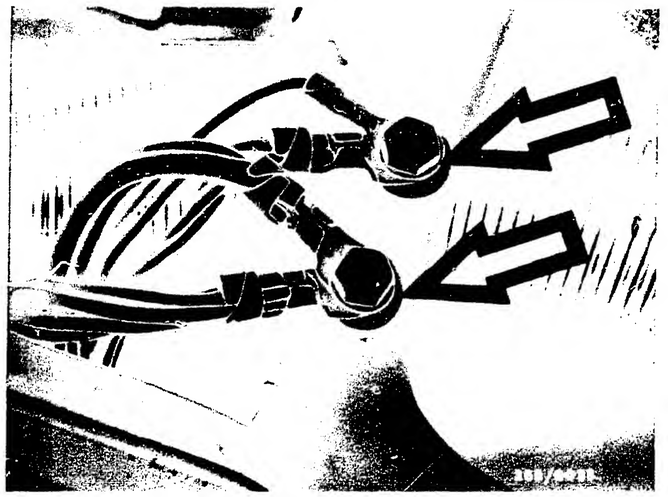
Note:

Upper illustration:
Ground terminal (Item 1) Type 116
(Type 107 similar).

Middle illustration:
Ground terminal (arrows) Type 123

Lower illustration:
Ground terminals (arrows) Type 126





TEST STEP 9 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Ground connection term.34.
Contact resistance.

N>

Operation:
Program-switch position: 8

Illuminated button lights up, press button.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
60...250 mV

Is the measured value within the test-specification tolerance range ?

Y

V

Continued on next coordinate

Trouble-shooting:
(Switch off ignition)

1. Reading less than 60 mV:

   Have tester inspected.

2. Reading greater than 250 mV:

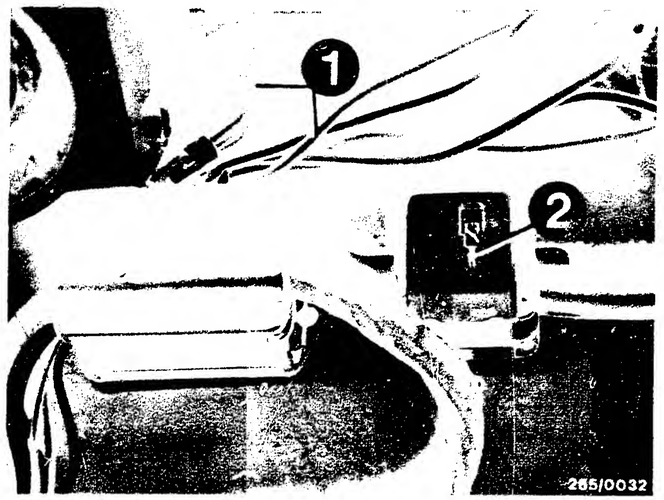
   Test ground terminal for excessive contact resistance and open circuit. Test lead for open circuit:
   From ground to controller plug K1/term.34.

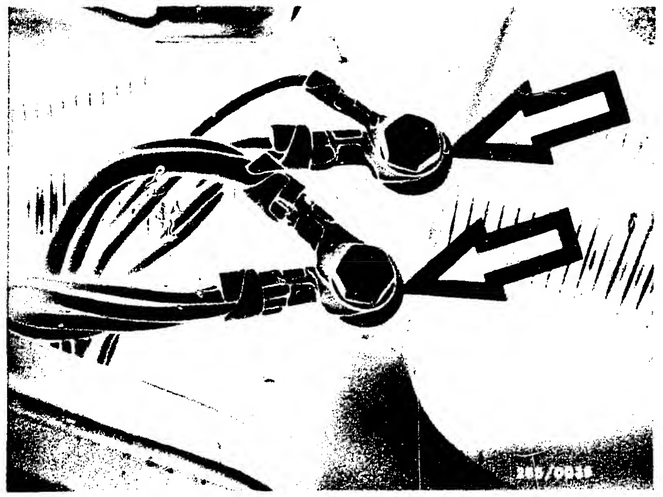
Note:

Upper illustration:
Ground terminal (Item 1) Type 116
(Type 107 similar)

Middle illustration:
Ground terminals (arrows) Type 123

Lower illustration:
Ground terminals (arrows) Type 126





TEST STEP 10 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Ground connection term.20.
Contact resistance.

Operation:
Program-switch position: 9

Illuminated button lights up, press button.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
60...250 mV

Is the measured value within the test-specification tolerance range ?.

N>

Trouble-shooting:
(Switch off ignition)

1. Reading less than 60 mV:

   Have tester inspected.

2. Reading greater than 250 mV:

   Test ground terminal for excessive contact resistance and open circuit. Test lead for open circuit:
   From ground to controller plug K1/term.20.

Note:

Upper illustration:
Ground terminal (Item 1) Type 116
(Type 107 similar)

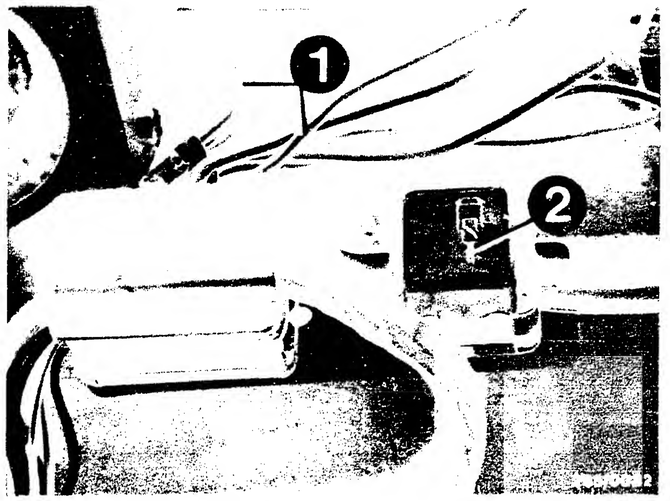
Middle illustration:
Ground terminals (arrows) Type 123

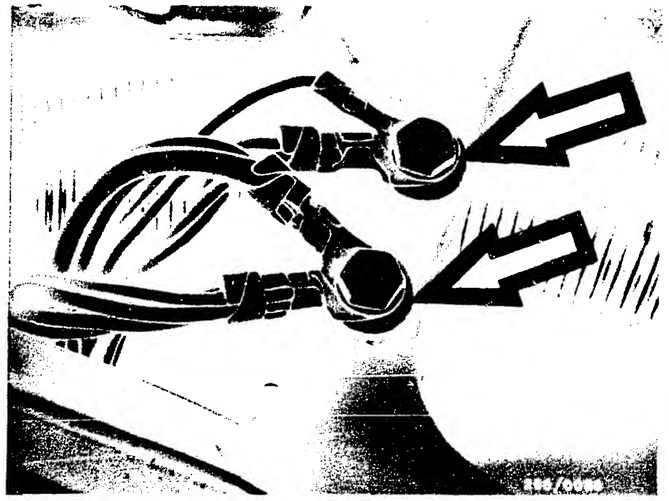
Lower illustration:
Ground terminals (arrows) Type 126

Y

V

Continued on next coordinate





Components/Function:
Internal resistance of left and right front wheel-speed sensors.

Operation: 10
Program-switch position:

Press the VL and VR buttons one after the other.
Note the reading after each button is pressed.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
0,9...2,2 k Ω 1)

Is the measured value within the test-specification tolerance range ?

N>

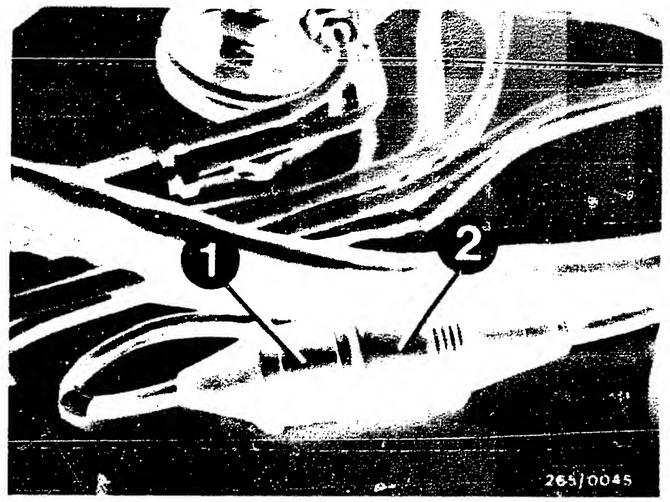
1) = Note:

The customer complaint

"warning lamp lighting up occasionally; after renewed starting, warning lamp stays off"

may possibly be due to a loose contact in the wheel-speed sensor leads or the 2-pin wheel-speed sensor plug connectors.
The problem is due to temporary open-circuits or touching of wires, caused by vibrations or changes in loading.

Locate the fault using the following test method.



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

Continued D15

Continued on next coordinate

Note:

Method of testing for loose contacts on wheel-speed sensors:

* One after the other, select all 4 wheel-speed sensors by pressing the respective key.

* When a wheel-speed sensor has been selected, move, bend and pull the appropriate cable directly at the wheel-speed sensor and at the fastening points, and particularly at the rubber buffers and the 2-pin plug connector.

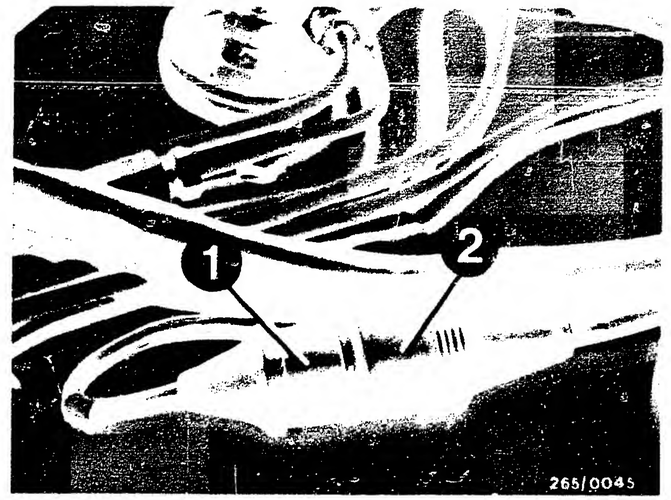
* At the same time, watch the digital display on the tester: If the digital display changes sharply there is a loose contact. If there is an open circuit the reading rises (max. 999); if there is a short circuit (usually at the wiring-harness plug) the reading falls (min. 000).

* Replace wheel-speed sensor.

Testing the wheel-speed sensor plug connectors:

* If the wheel-speed sensor leads are O.K., the 2-pin plug connectors of the wheel-speed sensors on the wiring-harness side must be tested in the same manner for loose contacts.

* If there is a loose contact at a 2-pin plug connector (wiring-harness side), it must be repaired with the repair kit.



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

Trouble-shooting (switch off ignition)

1. Measure internal resistance at disconnected couplings.
   If set value not reached: Replace the corresponding wheel-speed sensor.

2. Test the following leads for continuity:
   From plug K11 to controller plug K1/terms. 6 and 4.
   From plug K13 to controller plug K1/terms. 23 and 21.

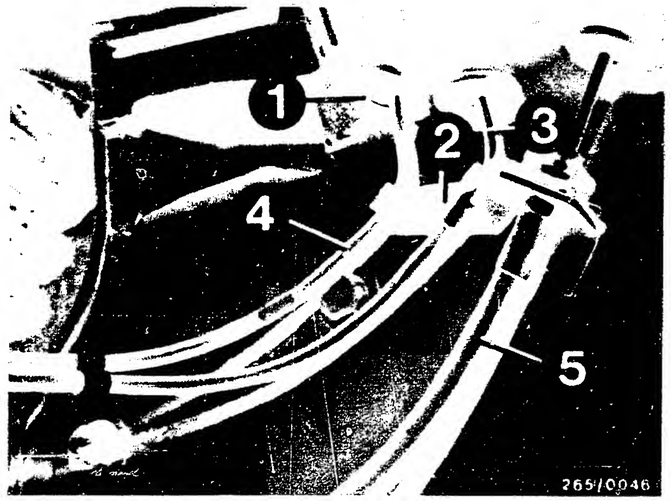
3. Inspect plug connections:

Removing the wheel-speed sensors from the front axle:

* Separate the wheel-speed sensor plug connection in the engine compartment.

* Remove lead (4) from holder (2) and pull through the rubber grommet (1) downwards out of the wheel well.

* Remove the protective tube (1) in the lower illustration from the cover plate.



Cable routing in wheel well
1 = Rubber grommet
2 = Holder
3 = Cable for wear indicator
4 = Lead for wheel-speed sensor
5 = Brake hose

1 = Protective tube

* Unscrew Allen-head screw (3) and pull the wheel-speed sensor (1) out of the steering knuckle.

* Remove wheel-speed sensor complete with cable and protective tube.

Installing wheel-speed sensors on the front axle

The left and right wheel-speed sensors have differing protective tubes. For identification purposes, an L or R are stamped into the holders of the protective tubes.
Before installing the wheel-speed sensors, make sure that no metallic foreign objects are on the permanent-magnet tips.

* Grease the sensor housing with Molykote Longterm 2 lubricant.

* Press the sensor (1) carefully into the steering knuckle. Do not strike!
  While doing this, make certain that the O-ring (4) does not become damaged.

* Fasten the wheel-speed sensor to the steering knuckle with an Allen-head screw (3). Self-locking Allen-head screws may be used only once.

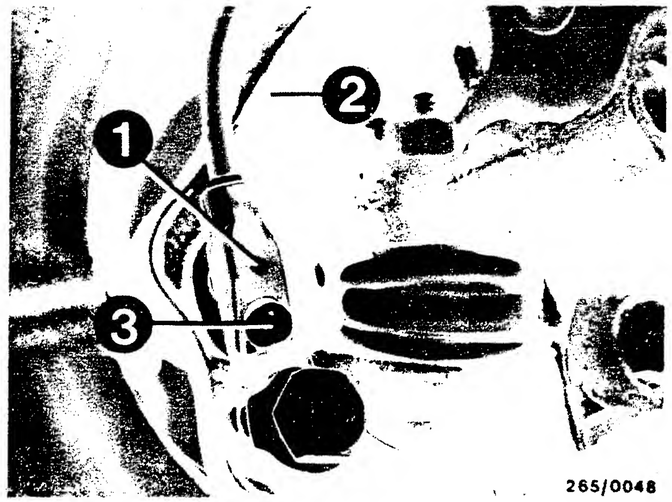
* Fasten the protection tube to the cover plate.

* Clip the lead into the holder and pull it through the rubber grommet into the engine compartment.

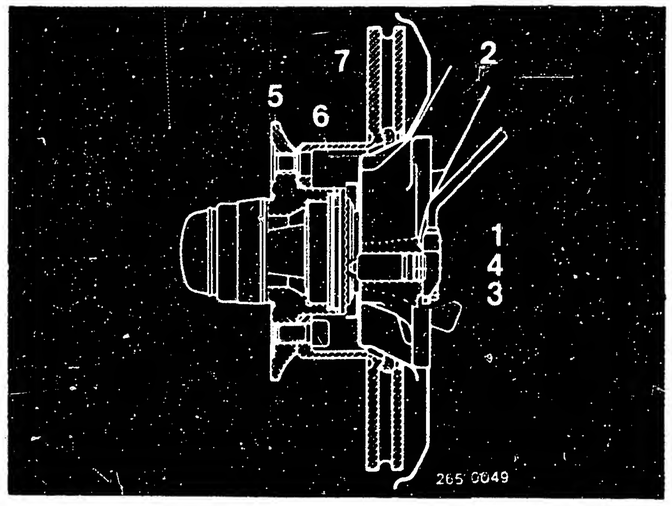
* Plug the coaxial plug connection together, making sure that the O-ring is correctly seated.

* After repair, test with ABS-tester.

Note:
On cars where the cables for the brake-pad wear indicator and the wheel-speed sensor are combined, when carrying out repairs convert to separate configuration. At the same time, the cable holder on the brake hose must be replaced.



1 = Wheel-speed sensor
2 = Steering knuckle
3 = Allen-head screw
4 = O-ring
5 = Front wheel hub
6 = Teeth (rotor)
7 = Brake disc



TEST STEP 12 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

Component/function:
Internal resistance of wheel-speed sensor on rear axle

N>

Operation:
Program-switch position: 10

Press key HA.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
0,6...1,6 k Ω 1)

Is measured value within the test-specification tolerance?

Y

Continued D25

1) = Note:

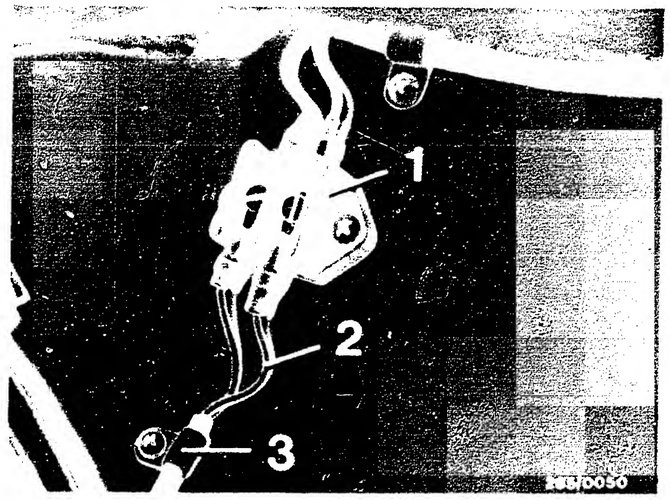
The customer complaint

"warning lamp lighting up occasionally; after renewed starting, warning lamp stays off"

may possibly be due to a loose contact in the wheel-speed sensor leads or the 2-pin wheel-speed sensor plug connectors.
The problem is due to temporary open-circuits or touching of wires, caused by vibrations or changes in loading.

Locate the fault using the following test method:

Continued on next coordinate



1 = Multiple butt connector
2 = Lead
3 = Clamp

1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw

Note:

Method of testing for loose contacts on wheel-speed sensors:

* One after the other, select all 4 wheel-speed sensors by pressing the respective key.

* When a wheel-speed sensor has been selected, move, bend and pull the appropriate cable directly at the wheel-speed sensor and at the fastening points, and particularly at the rubber buffers and the 2-pin plug connector.

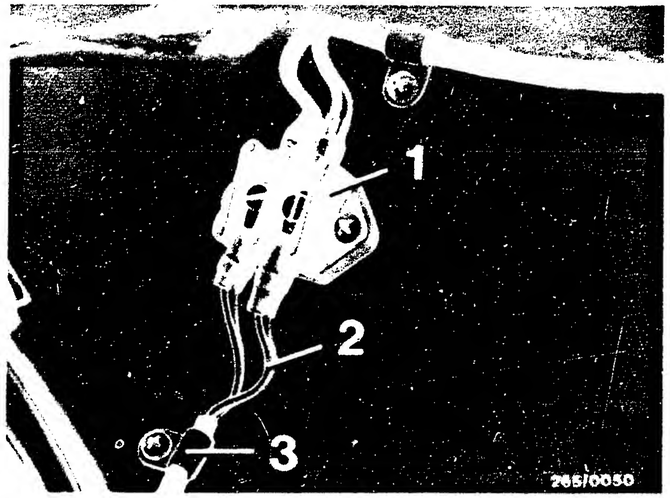
* At the same time, watch the digital display on the tester: If the digital display changes sharply there is a loose contact. If there is an open circuit the reading rises (max. 999); if there is a short circuit (usually at the wiring-harness plug) the reading falls (min. 000).

* Replace wheel-speed sensor.

Testing the wheel-speed sensor plug connectors:

* If the wheel-speed sensor leads are O.K., the 2-pin plug connectors of the wheel-speed sensors on the wiring-harness side must be tested in the same manner for loose contacts.

* If there is a loose contact at a 2-pin plug connector (wiring-harness side), it must be repaired with the repair kit.



1 = Multiple butt connector
2 = Lead
3 = Clamp

Trouble-shooting (switch off ignition)

1. Measure internal resistance at multiple butt connector.
   If set value is not reached: Replace wheel-speed sensor.

2. Check the following leads for continuity:
   From plug K15 to controller plug K1/terms.7 and 9.

3. Inspect screwed connections.

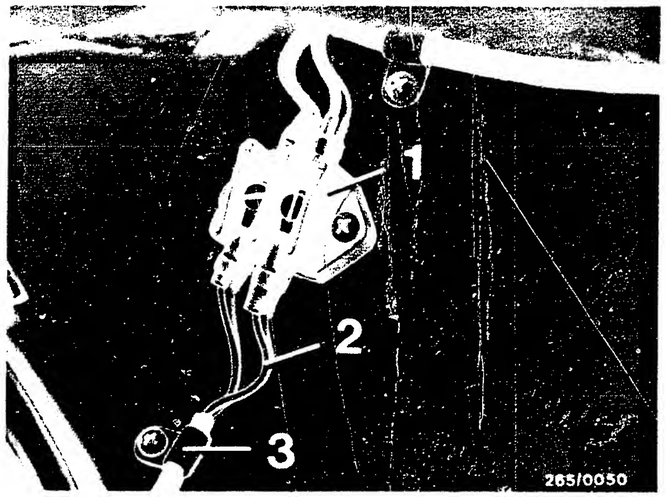
Removing the wheel-speed sensor from the rear axle:

* Remove the rear seat bench and backrest.

* Switch off ignition and disconnect leads in multiple butt connector; unscrew clamps.

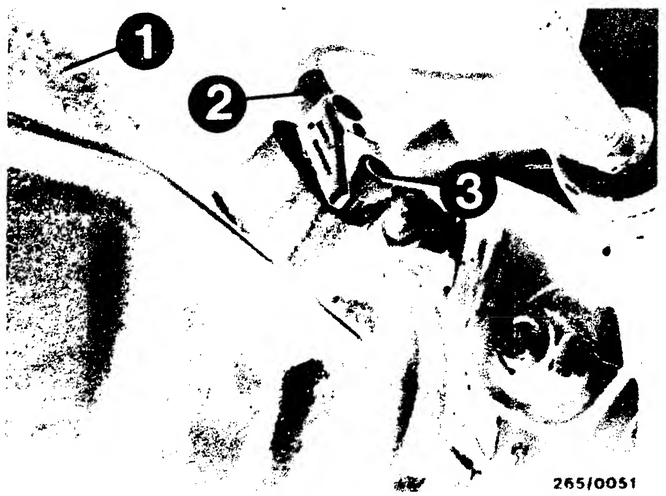
* Pull the lead downwards through the rubber grommet in the frame floor and the axle support.

* Unscrew Allen-head screw (3) and take the wheel-speed sensor (2) out of the rear-axle housing (1).



1 = Multiple butt connector
2 = Lead
3 = Clamp

1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw



Installing the wheel-speed sensor at the rear axle

I M P O R T A N T !

Before installing the wheel-speed sensor, make sure that there are no metallic foreign bodies on the permanent-magnet tip.

* Replace O-ring!

* Grease the wheel-speed sensor with Molykote Longterm 2 lubricant.

* Insert the wheel-speed sensor (2) into the rear-axle housing (1), making sure that the O-ring (4), does not become damaged. Do not use force.

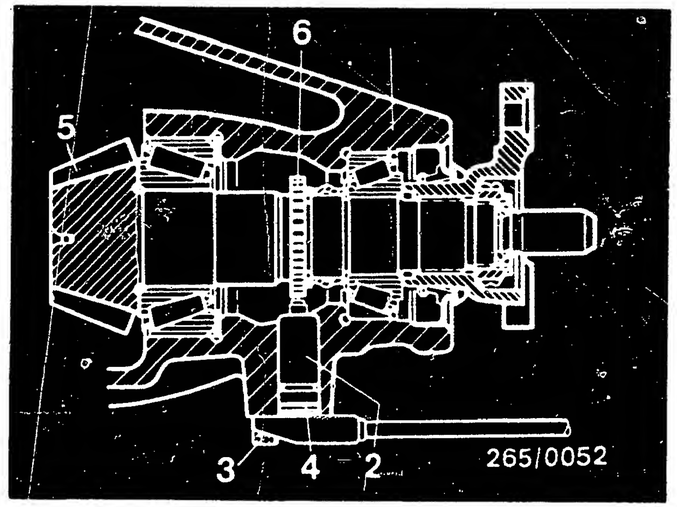
* Fasten the sensor to the rear-axle center housing with the Allen-head screw (3). The self-locking Allen-head screw may be used only once.

* Pull the lead for the wheel-speed sensor upwards through the rubber grommet in the axle support and frame floor and connect to the multiple butt connector.

* Fasten the wheel-speed sensor lead with clamps.

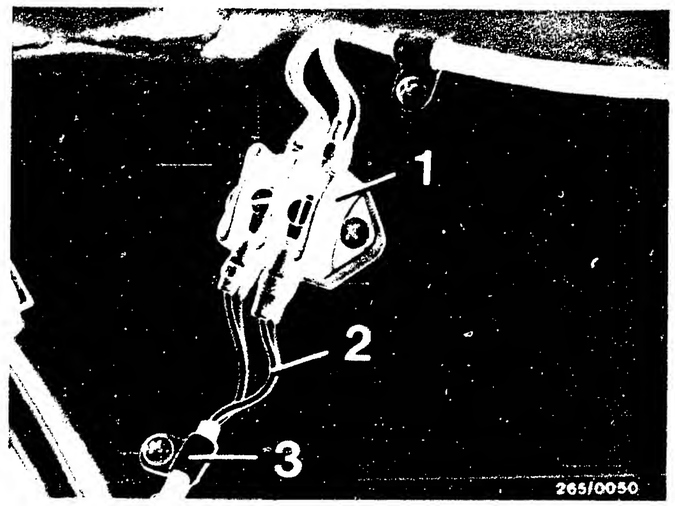
* Install the rear seat bench and backrest.

* After repair test with ABS-tester.



1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw
4 = O-ring
5 = Drive bevel gear
6 = Gear (rotor)

1 = Multiple butt connector
2 = Lead
3 = Clamp



TEST STEP 13 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

Component/Function:
Insulation resistance of wheel-speed sensor, front left and front right.

Operation:
Program-selector switch position: 11

Press buttons VL and VR one after the other.
After each time button is pressed, read off reading.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
20...999 k Ω

Is measured value in each case within the test-specifications tolerance?

N>

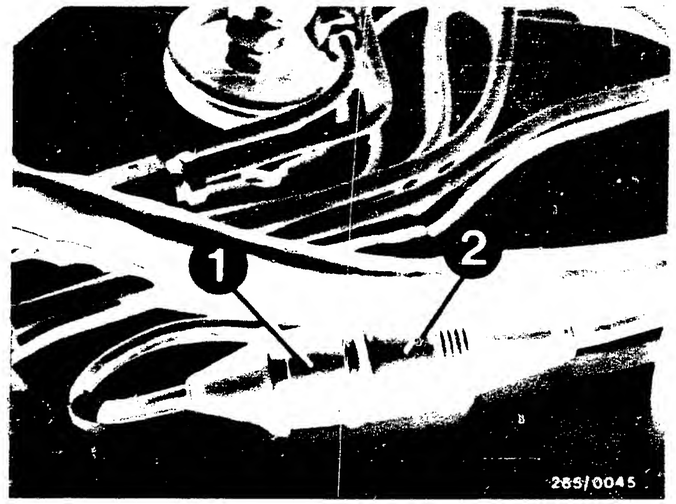
Trouble-shooting
(switch off ignition):

Plug connectors O.K.?

Pull apart plug connectors and bridge the plug which leads to tester using wire.

Repeat test:
If the reading is now O.K., replace wheel-speed sensor.
If the reading is still below the set value, the leads from controller plug term.6 and term.4 or term.23 and term.21 to the respective plug are defective.

Check all leads for wear and short circuit to ground.



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

Y

Continued E09

Continued on next coordinate

D23 D24

Removing wheel-speed sensors from front axle

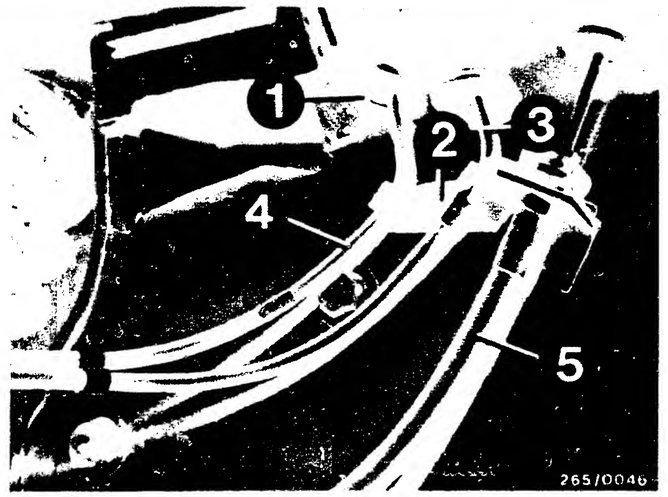
* Disconnect wheel-speed sensor plug connection in engine compartment.

* Remove lead (4) from holder (2) and pull through the rubber grommet (1) down out of the wheel well.

* Remove protective tube from cover plate.

* Unscrew fastening of lead on wheel-bearing housing and wheel well.

* Unscrew the fastening screw for the wheel-speed sensor and pull the sensor out.
  Do not use force!



Cable routing in wheel well
1 = Rubber grommet
2 = Holder
3 = Cable for wear indicator
4 = Lead for wheel-speed sensor
5 = Brake hose

1 = Protective tube

* Unscrew Allen-head screw (3) and pull the wheel-speed sensor (1) out of the steering knuckle.

* Remove wheel-speed sensor complete with cable and protective tube.

Installing wheel-speed sensors on the front axle

The left and right wheel-speed sensors have differing protective tubes. For identification purposes, an L or R are stamped into the holders of the protective tubes.
Before installing the wheel-speed sensors, make sure that no metallic foreign objects are on the permanent-magnet tips.

* Grease the sensor housing with Molykote Longterm 2 lubricant.

* Press the sensor (1) carefully into the steering knuckle. Do not strike!
While doing this, make certain that the O-ring (4) does not become damaged.

* Fasten the wheel-speed sensor to the steering knuckle with an Allen-head screw (3). Self-locking Allen-head screws may be used only once.

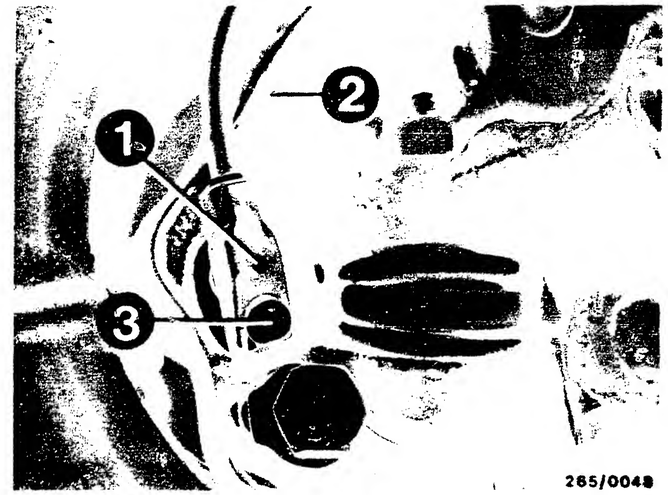
* Fasten the protection tube to the cover plate.

* Clip the lead into the holder and pull it through the rubber grommet into the engine compartment.

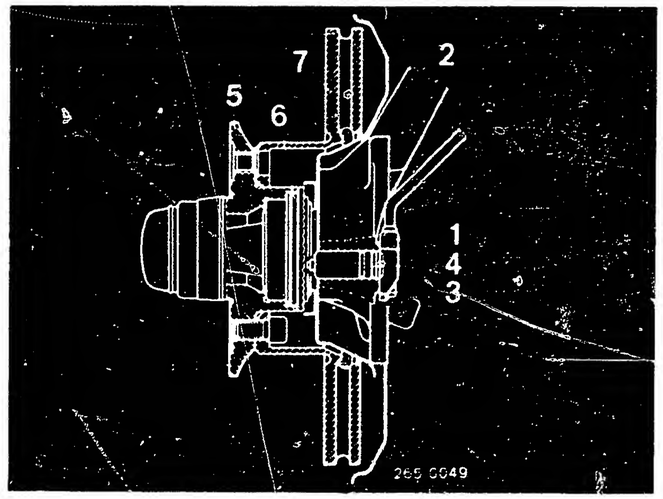
* Plug the coaxial plug connection together, making sure that the O-ring is correctly seated.

* After repair, test with ABS-tester.

Note:
On cars where the cables for the brake-pad wear indicator and the wheel-speed sensor are combined, when carrying out repairs convert to separate configuration. At the same time, the cable holder on the brake hose must be replaced.



1 = Wheel-speed sensor
2 = Steering knuckle
3 = Allen-head screw
4 = O-ring
5 = Front wheel hub
6 = Teeth (rotor)
7 = Brake disc



Component/Function:
Insulation resistance of wheel-speed sensor, rear

Operation:
Program-selector switch position: 11

Press button HA

Operation in vehicle:
Switch on ignition.

Test specification (reading):
20...999 k Ω

Is measured value within the test-specifications tolerance?

N>

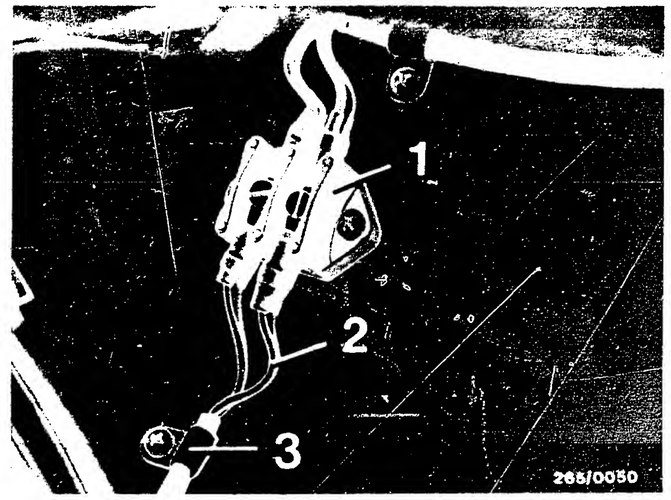
Trouble-shooting
(switch off ignition):

Multiple butt connector O.K.?

Pull apart lead connection and bridge the plug which leads to the tester using wire.

Repeat test:
If reading now O.K., replace wheel-speed sensor.
If reading still below the set value, the leads from controller plug term.7 and term.9 to the respective plug are defective.

Check all leads for wear and short circuit to ground.



1 = Multiple butt connector
2 = Lead
3 = Clamp

Continued on next coordinate

Continued on next coordinate

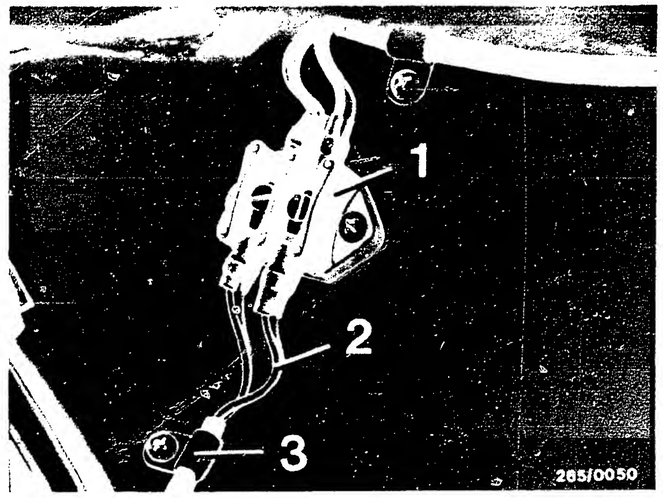
Removing the wheel-speed sensor from rear axle

* Remove the rear seat bench and backrest.

* Switch off ignition and disconnect the leads in the multiple butt connector, and then unscrew clamps.

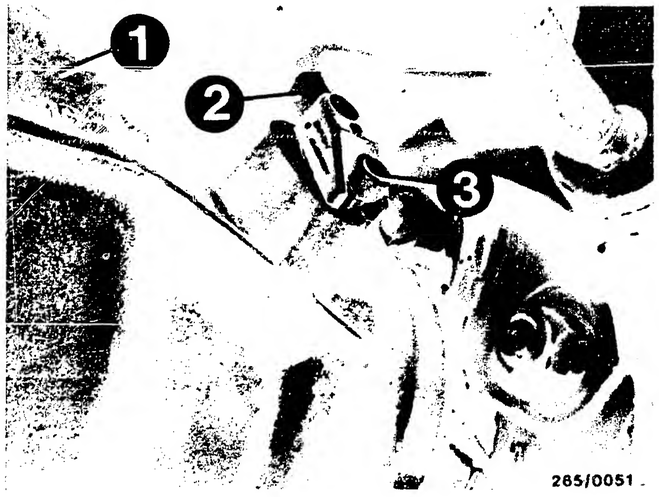
* Pull the lead all the way down out of the rubber grommet in the frame floor and axle support.

* Unscrew the Allen-head screw and pull the wheel-speed sensor out of the rear-axle housing.



1 = Multiple butt connector
2 = Lead
3 = Clamp

1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw



Installing the wheel-speed sensor at the rear axle

I M P O R T A N T !

Before installing the wheel-speed sensor, make sure that there are no metallic foreign bodies on the permanent-magnet tip.

* Replace O-ring!

* Grease the wheel-speed sensor with Molykote Longterm 2 lubricant.

* Insert the wheel-speed sensor (2) into the rear-axle housing (1), making sure that the O-ring (4), does not become damaged. Do not use force.

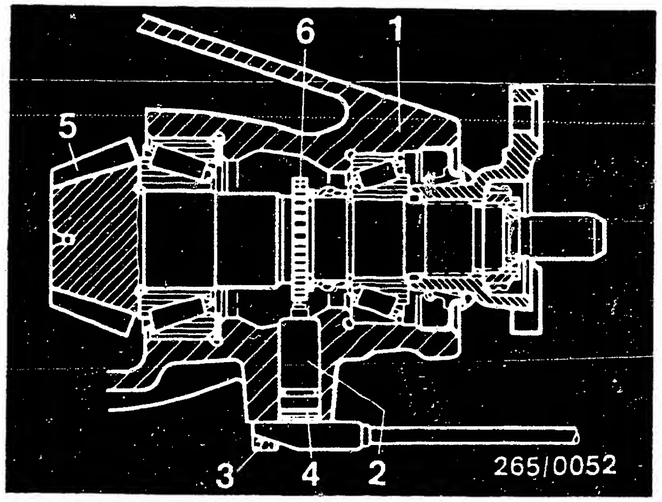
* Fasten the sensor to the rear-axle center housing with the Allen-head screw (3). The self-locking Allen-head screw may be used only once.

* Pull the lead for the wheel-speed sensor upwards through the rubber grommet in the axle support and frame floor and connect to the multiple butt connector.

* Fasten the wheel-speed sensor lead with clamps.

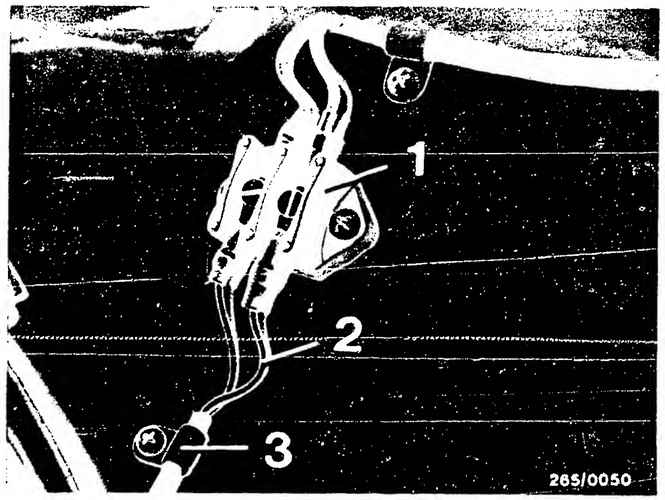
* Install the rear seat bench and backrest.

* After repair test with ABS-tester.



1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw
4 = O-ring
5 = Drive bevel gear
6 = Gear (rotor)

1 = Multiple butt connector
2 = Lead
3 = Clamp



TEST STEP 15 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
DC voltage of left and right front wheel-speed sensor leads.

Operation:
Program-switch position: 12

Press the VL and VR buttons one after the other.
Note reading after pressing each button.

Operation in vehicle:
Switch on ignition.

Test specification (reading):

000...100 mV

Is the measured value within the test-specification tolerance range each time ?

N>

Trouble-shooting
(switch off ignition):

Plug connectors O.K.?

Pull apart plug connectors and bridge the plug which leads to tester using wire.

Repeat test:
If the reading is now O.K., replace wheel-speed sensor.
If the reading is still below the set value, the leads from controller plug term.6 and term.4 or term.23 and term.21 to the respective plug are defective.

Check all leads for wear and short circuit to ground.

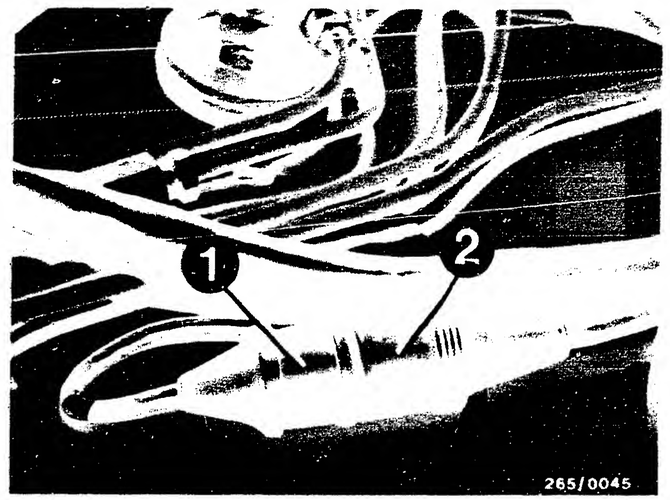
Y

V

Continued E15

V

Continued on next coordinate



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

Removing wheel-speed sensors from front axle

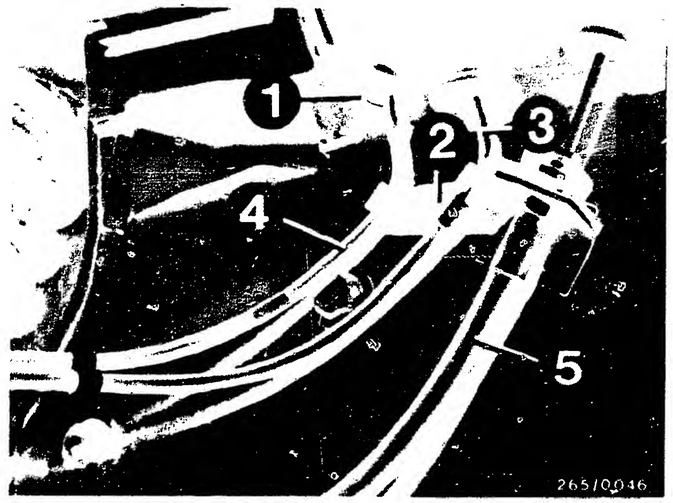
* Disconnect wheel-speed sensor plug connection in engine compartment.

* Remove lead (4) from holder (2) and pull through the rubber grommet (1) down out of the wheel well.

* Remove protective tube from cover plate.

* Unscrew fastening of lead on wheel-bearing housing and wheel well.

* Unscrew the fastening screw for the wheel-speed sensor and pull the sensor out.
Do not use force!



Cable routing in wheel well
1 = Rubber grommet
2 = Holder
3 = Cable for wear indicator
4 = Lead for wheel-speed sensor
5 = Brake hose

1 = Protective tube

* Unscrew Allen-head screw (3) and pull the wheel-speed sensor (1) out of the steering knuckle.

* Remove wheel-speed sensor complete with cable and protective tube.

Installing wheel-speed sensors on the front axle

The left and right wheel-speed sensors have differing protective tubes. For identification purposes, an L or R are stamped into the holders of the protective tubes.
Before installing the wheel-speed sensors, make sure that no metallic foreign objects are on the permanent-magnet tips.

* Grease the sensor housing with Molykote Longterm 2 lubricant.

* Press the sensor (1) carefully into the steering knuckle. Do not strike!
  While doing this, make certain that the O-ring (4) does not become damaged.

* Fasten the wheel-speed sensor to the steering knuckle with an Allen-head screw (3). Self-locking Allen-head screws may be used only once.

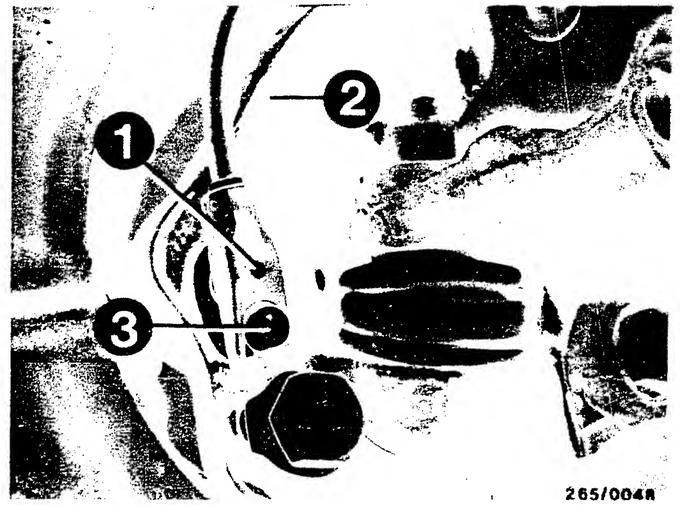
* Fasten the protection tube to the cover plate.

* Clip the lead into the holder and pull it through the rubber grommet into the engine compartment.

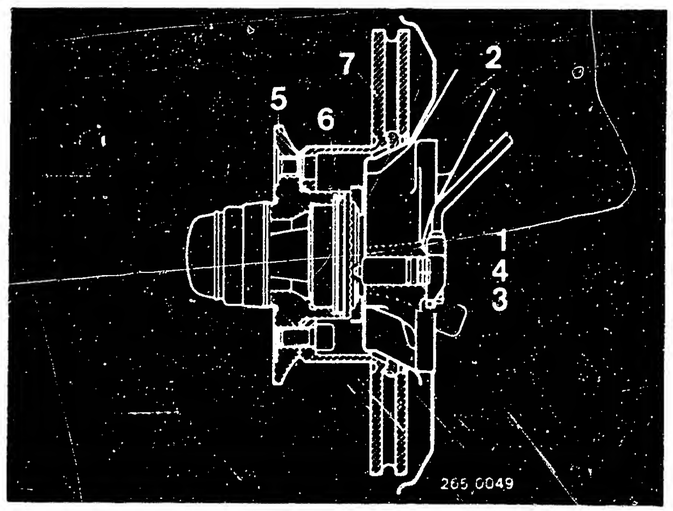
* Plug the coaxial plug connection together, making sure that the O-ring is correctly seated.

* After repair, test with ABS-tester.

Note:
On cars where the cables for the brake-pad wear indicator and the wheel-speed sensor are combined, when carrying out repairs convert to separate configuration. At the same time, the cable holder on the brake hose must be replaced.



1 = Wheel-speed sensor
2 = Steering knuckle
3 = Allen-head screw
4 = O-ring
5 = Front wheel hub
6 = Teeth (rotor)
7 = Brake disc



TEST STEP 16 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
DC voltage on wheel-speed sensor lead, rear

N>

Operation:
Program-selector switch position: 12

Press button HA.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
000...100 mV

Is measured value in each case within the test-specifications tolerance?

Y

V

Continued E21

Trouble-shooting
(switch off ignition):

Multiple butt connector O.K.?

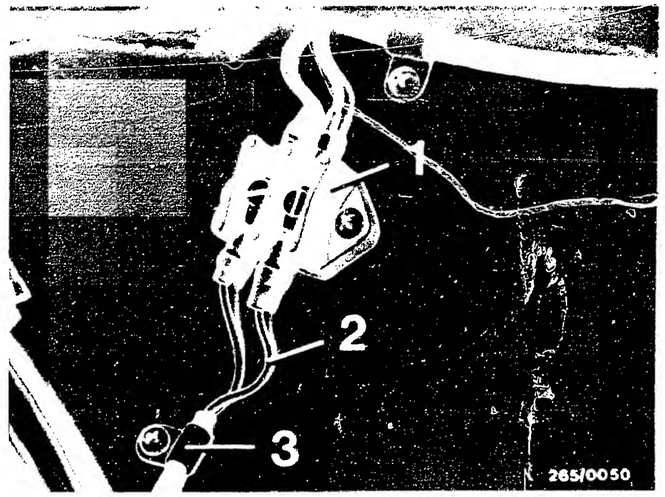
Pull apart lead connection and bridge the plug which leads to the tester using wire.

Repeat test:
If reading now O.K., replace wheel-speed sensor.
If reading still below the set value, the leads from controller plug term.7 and term.9 to the respective plug are defective.

Check all leads for wear and short circuit to ground.

V

Continued on next coordinate



1 = Multiple butt connector
2 = Lead
3 = Clamp

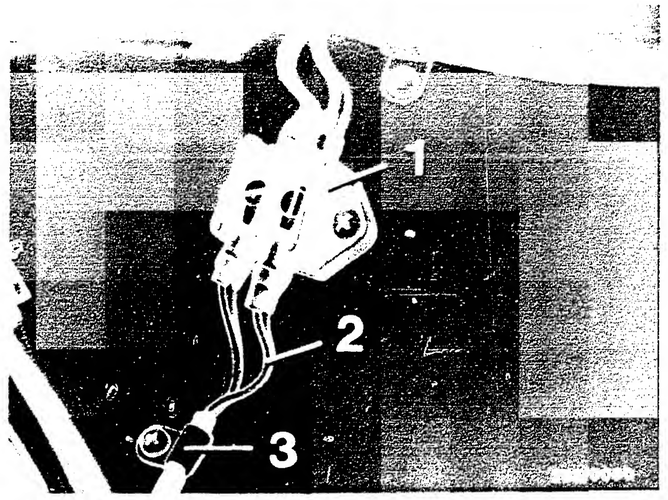
Removing the wheel-speed sensor from rear axle

* Remove the rear seat bench and backrest.

* Switch off ignition and disconnect the leads in the multiple butt connector, and then unscrew clamps.

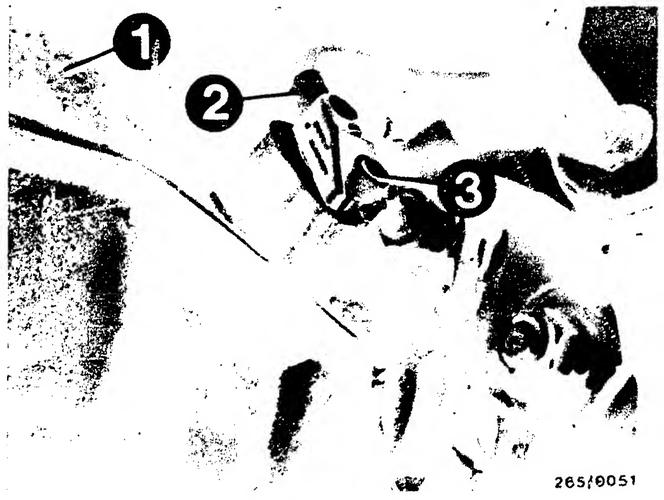
* Pull the lead all the way down out of the rubber grommet in the frame floor and axle support.

* Unscrew the Allen-head screw and pull the wheel-speed sensor out of the rear-axle housing.



1 = Multiple butt connector
2 = Lead
3 = Clamp

1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw



Installing the wheel-speed sensor at the rear axle

I M P O R T A N T !

Before installing the wheel-speed sensor, make sure that there are no metallic foreign bodies on the permanent-magnet tip.

* Replace O-ring!

* Grease the wheel-speed sensor with Molykote Longterm 2 lubricant.

* Insert the wheel-speed sensor (2) into the rear-axle housing (1), making sure that the O-ring (4), does not become damaged. Do not use force.

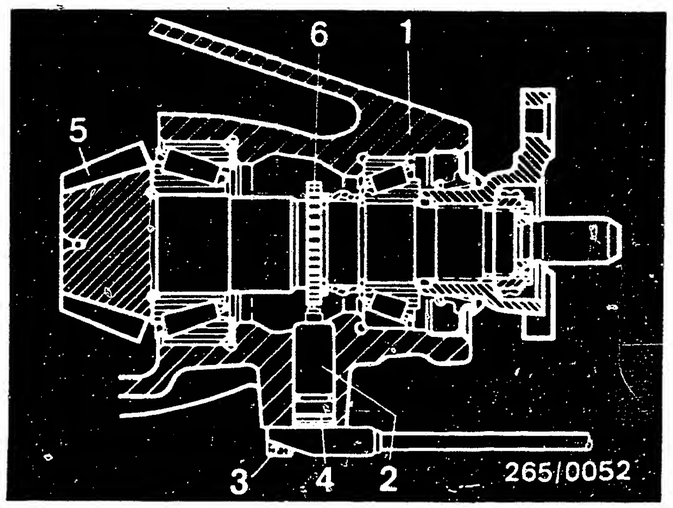
* Fasten the sensor to the rear-axle center housing with the Allen-head screw (3). The self-locking Allen-head screw may be used only once.

* Pull the lead for the wheel-speed sensor upwards through the rubber grommet in the axle support and frame floor and connect to the multiple butt connector.

* Fasten the wheel-speed sensor lead with clamps.

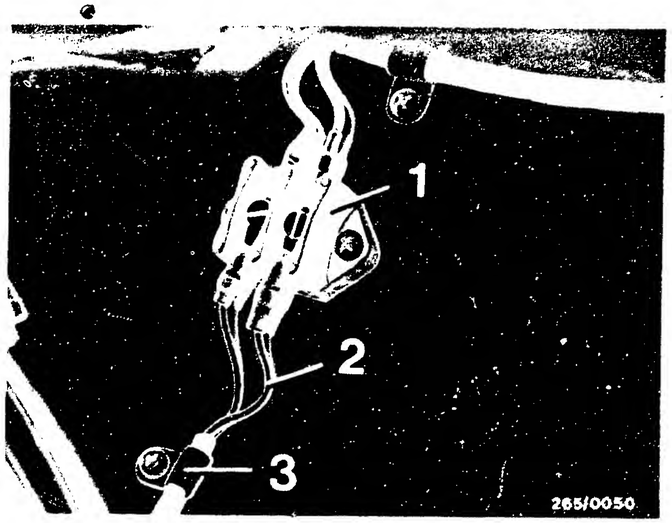
* Install the rear seat bench and backrest.

* After repair test with ABS-tester.



1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw
4 = O-ring
5 = Drive bevel gear
6 = Gear (rotor)

1 = Multiple butt connector
2 = Lead
3 = Clamp



TEST STEP 17 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function
Controller.
Internal supply voltage.

Operation:
Program-selector switch position: 13

Illuminated key lights up, press key.

Operation in vehicle:
Switch on ignition.

Test specification (reading):

8,85...9,15 V

As of 1984:
valid for generation 2 B:
4,75...5,25 V

Is measured value in each case within the test-specifications tolerance?

N>

Trouble-shooting:
Replace controller (switch off ignition beforehand.

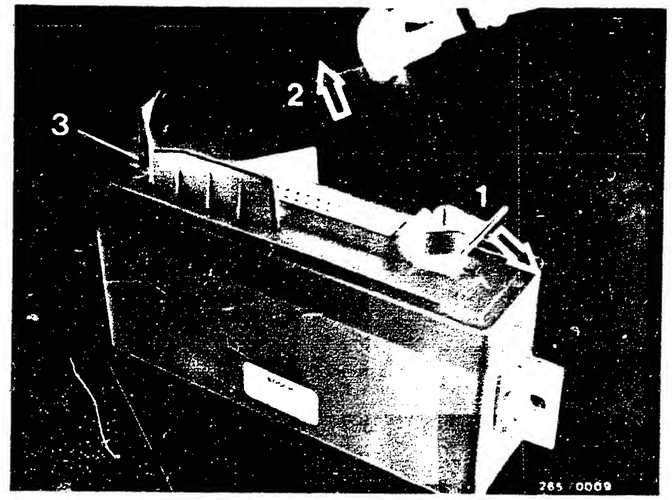
Notes:

* Switch off ignition before disconnecting controller plug.

* Push back spring to disconnect the controller plug, bend controller plug upward and unhook from encoding block.

* Install only specified controller!

* When installing, make sure that controller plug latches into spring.



1 = Spring
2 = Controller plug (35-pin)
3 = Encoding unit

Y

V

Continued on next coordinate

TEST STEP 18 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator and warning lamp.
Diode in conducting direction.

N>

Operation:
Program-switch position: 14

Operation in vehicle:
Switch on ignition.

Test specification (reading):
* 0,4...1,5 V
* ABS warning lamp in vehicle must light up.

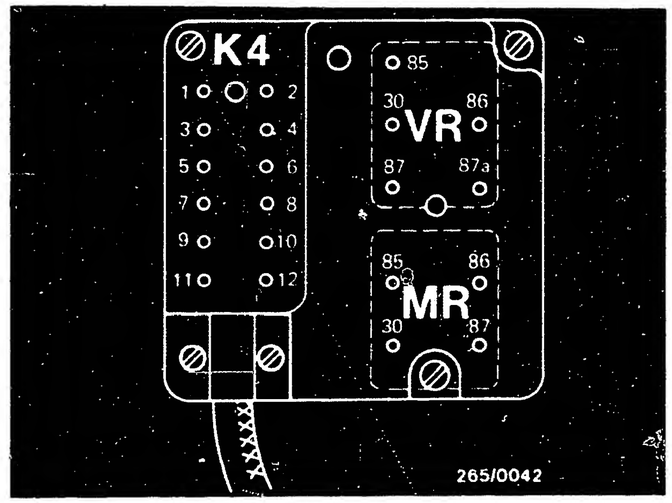
Is the measured value within the test-specification tolerance range ?

Does the warning lamp light up ?

Trouble-shooting:
(Switch off ignition)

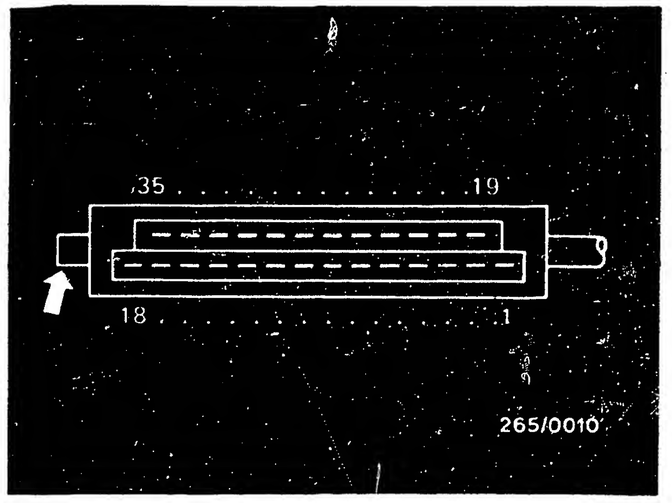
Warning lamp does not come on:
1. Warning lamp defective.
2. Open circuit in lead to ignition lock.
3. Test leads from controller plug K1/term. 29 to hydraulic modulator K3/term. 7 for open circuit.
4. Test diode in conducting and reverse directions between K4/term. 7 and K4/term. 4 with ohmmeter (until 7.85).
   From 8.85, test diode in conducting and reverse directions directly at the valve-relay plug between L1 and term. 30.

Reading outside of tolerance:
1. Test diode with ohmmeter in conducting and reverse directions between K4/term. 7 and K4/term. 4 (until 7.85).
   From 8.85, test directly on valve-relay plug between terms. L and 30.
2. Test lead between controller plug K1/term. 29 and ABS warning lamp for open circuit.



Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug

Top view of controller plug K1 (35-pin) with terminal numbers
Arrow = Mechanically-coded lug



Y

V

Continued F03

V

Continued on next coordinate

TEST STEP 18 (CONTINUED) (TEST SPECIFICATIONS AND OPERATING INSTRUCTIONS)

Until 7.85

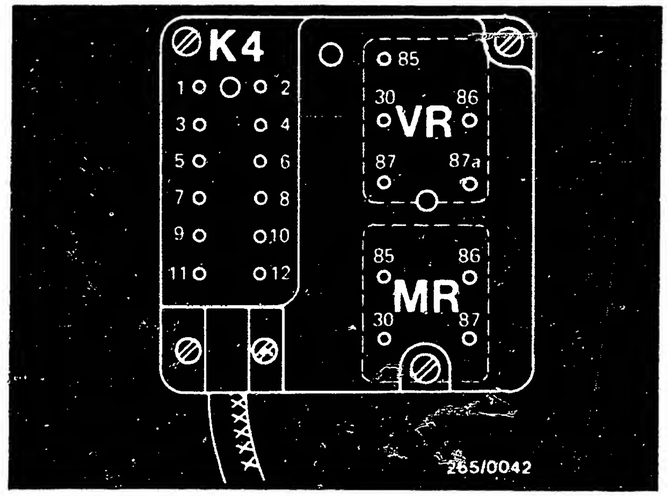
3. Test plug connections at warning lamp K3/term. 7, K4/term. 7, K3/term. 8, K4/term. 8 as well as ground lead and valve-relay plug connection for voltage drop.

   If diode is defective, replace the hydraulic modulator.

From 8.85

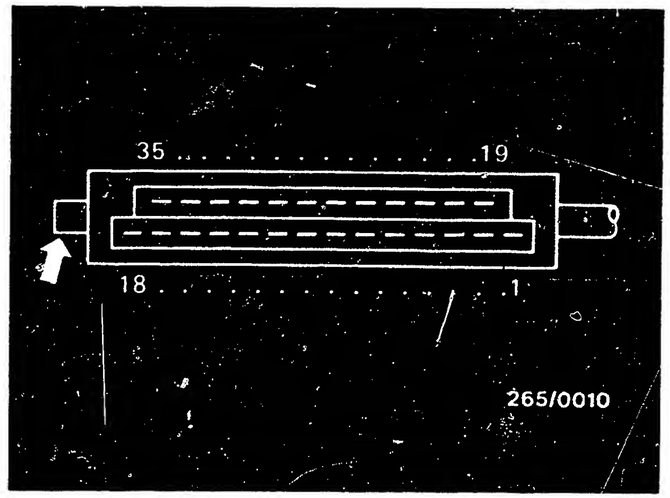
   Test plug connection at warning lamp K3/term. 7, K4/term. 7, ground connection from pump-motor ground to valve relay term. 87a and valve-relay plug connections for voltage drop.

   If diode is defective, replace the valve relay.



Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug

Top view of controller plug K1 (35-pin) with terminal numbers
Arrow = Mechanically-coded lug



Continued F03

Continued on next coordinate

Removing the hydraulic modulator

* For safety reasons, the hydraulic modulator must not be repaired, but the complete unit must be replaced.

  Exceptions to this are the motor relay and the valve relay. Both relays may be replaced.

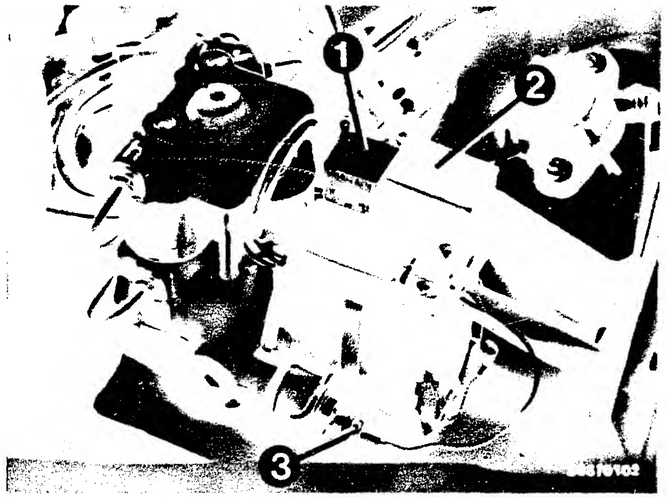
* Apart from the brake-line connections, it is not permissible to loosen any screws on the hydraulic modulator.

  In particular, the hexagon-socket-head cap screws may under no circumstances be loosened.

  After loosening, it is no longer possible to get the brake circuits leak-tight.
  D a n g e r!

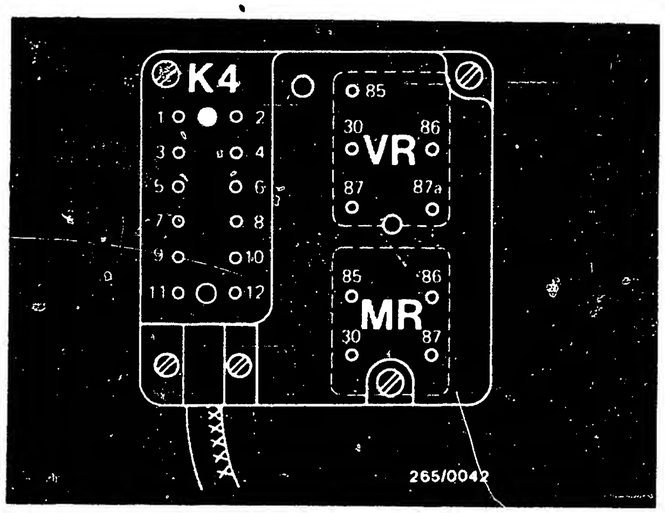
* Check the hydraulic modulator and brake-line connections for leaks by means of a visual examination.

  If brake fluid is escaping, tighten the brake-line connections (12...16 Nm) or replace, or replace the hydraulic modulator.



1 = Valve relay
2 = Motor relay
3 = Ground terminal

Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug



Pay particular attention to the joint identified by the arrows (upper illustration).

On the base of the hydraulic modulator there is a vent hole to the pump pistons.

A slight escape of brake fluid is possible at this point.

A complaint is only justified if, after pressing the brake pedal several times, a pool of brake fluid is formed under the hydraulic modulator.

* When removing and installing the brake lines, make sure that the lines are marked in accordance with the markings on the hydraulic modulator and that they are not mixed up when re-connecting (e.g. VL of hydraulic modulator must be connected to the front left wheel brake cylinder).

* Markings on hydraulic modulator:

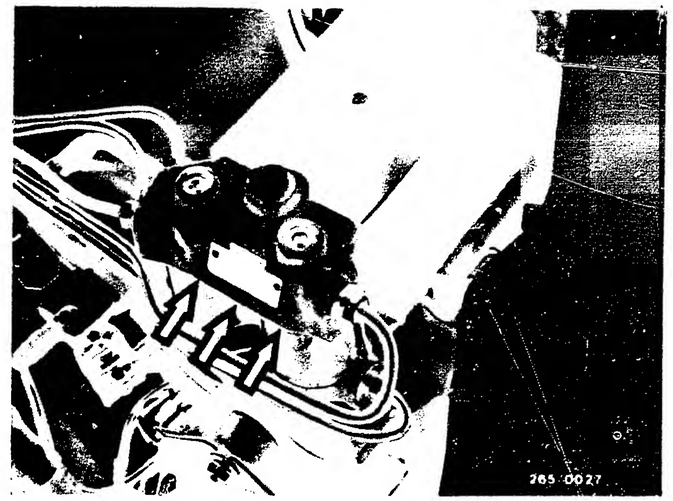
V = Front-axle brake circuit of staged tandem brake master cylinder

H = Rear-axle brake circuit of staged tandem brake master cylinder

l = Lead to wheel brake cylinder, front left

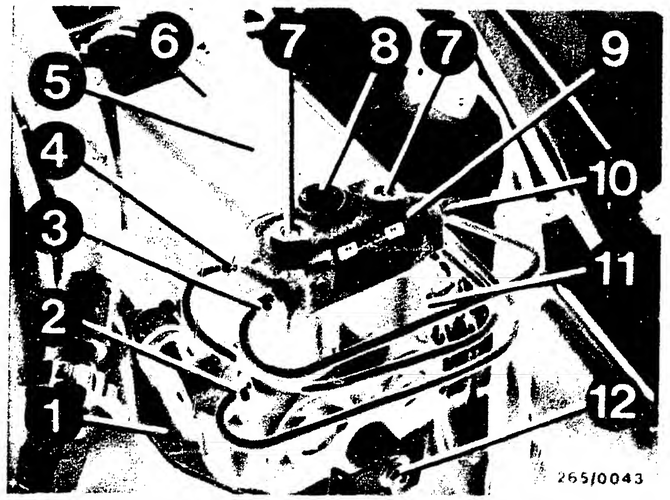
r = Lead to wheel brake cylinder, front right

h = Lead to the rear wheel brake cylinders.



Arrows = Sealing points

2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line



* Use only the specified double-end flare nut wrench 9 x 11 mm for loosening and tightening the brake lines.

* Mark brake lines and loosen from hydraulic modulator.

* Catch the brake fluid and do not bring it into contact with your skin or clothing or with paintwork!

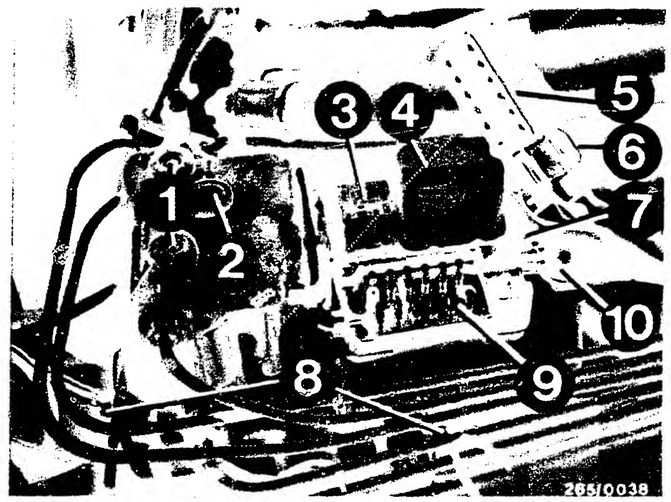
* Immediately seal the brake lines and connections with dummy plugs.

* Disconnect ground cable (7) from pump motor.

* Loosen fastening screw and remove cover.

* Loosen bracket (6) and remove plug (5).

* Loosen hexagon nuts (8) and remove hydraulic modulator.



5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)

Installation

* Mount hydraulic modulator in the holder and fasten with the hexagon nuts.

* Connect ground cable to pump motor.
Plug on 12-pin plug (5) and fasten with the bracket (6).

* Fasten cover on the hydraulic modulator with the screw.

* Connect the brake lines to the hydraulic modulator in accordance with the markings.

* Observe the tightening torque for the brake-line connections on the hydraulic modulator: 12...16Nm.

* Bleed the brake system and check for leaks.

* Fully test the ABS with the tester.

TEST STEP 19 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Diode in conducting direction.

Operation:
Program-switch position: 15

Operation in vehicle:
Switch on ignition.

Test specification (reading):
2,5...8,5 V

Note:
ABS warning lamp lights up somewhat less brightly.
Valve relay switches.

Is the measured value within the test-specification tolerance range in each case ?

N>

Trouble-shooting:
(Switch off ignition)

Reading outside of tolerance:

Until 7.85:

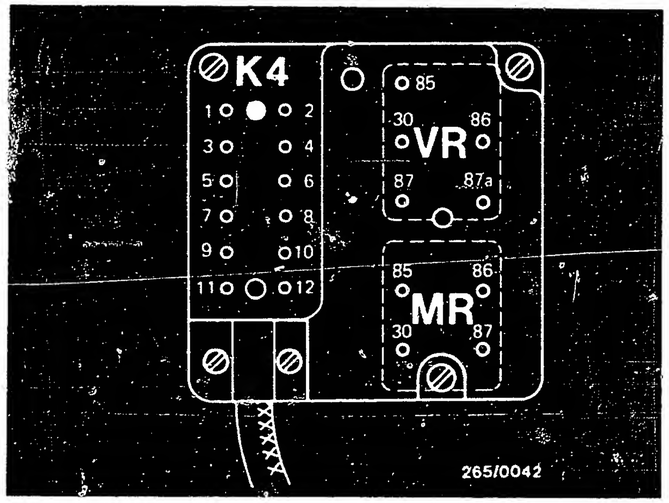
Test diode in conducting and reverse direction between K4/term. 7 and K4/term. 4 using ohmmeter.

If diode is defective, replace the hydraulic modulator.

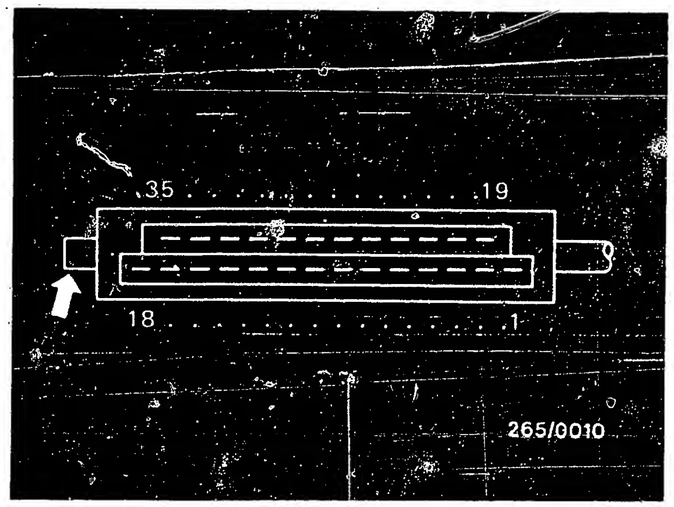
From 8.85:

Test diode in conducting and reverse directions with ohmmeter directly at valve-relay plug terms. L and 30.

If diode is defective, replace the valve relay.



Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug



Top view of controller plug K1 (35-pin) with terminal numbers
Arrow = Mechanically-coded lug

V

Continued F11

V

Continued on next coordinate

* Use only the specified double-end flare nut wrench 9 x 11 mm for loosening and tightening the brake lines.

* Mark brake lines and loosen from hydraulic modulator.

* Catch the brake fluid and do not bring it into contact with your skin or clothing or with paintwork!

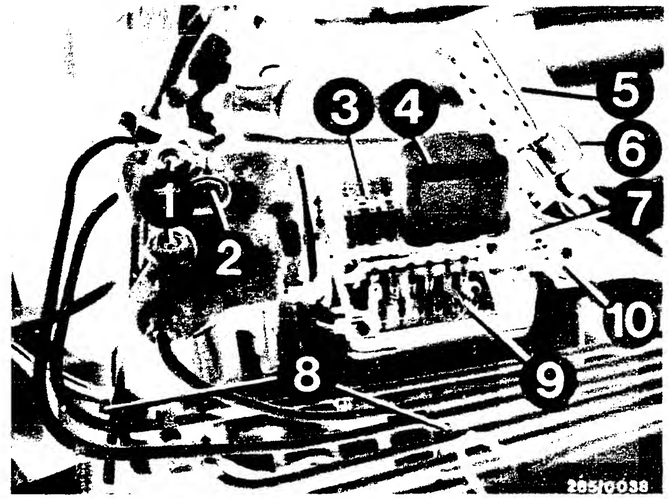
* Immediately seal the brake lines and connections with dummy plugs.

* Disconnect ground cable (7) from pump motor.

* Loosen fastening screw and remove cover.

* Loosen bracket (6) and remove plug (5).

* Loosen hexagon nuts (8) and remove hydraulic modulator.



5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)

Installation

* Mount hydraulic modulator in the holder and fasten with the hexagon nuts.

* Connect ground cable to pump motor.
Plug on 12-pin plug (5) and fasten with the bracket (6).

* Fasten cover on the hydraulic modulator with the screw.

* Connect the brake lines to the hydraulic modulator in accordance with the markings.

* Observe the tightening torque for the brake-line connections on the hydraulic modulator: 12...16Nm.

* Bleed the brake system and check for leaks.

* Fully test the ABS with the tester.

Pay particular attention to the joint identified by the arrows (upper illustration).

On the base of the hydraulic modulator there is a vent hole to the pump pistons.

A slight escape of brake fluid is possible at this point.

A complaint is only justified if, after pressing the brake pedal several times, a pool of brake fluid is formed under the hydraulic modulator.

* When removing and installing the brake lines, make sure that the lines are marked in accordance with the markings on the hydraulic modulator and that they are not mixed up when re-connecting (e.g. VL of hydraulic modulator must be connected to the front left wheel brake cylinder).

* Markings on hydraulic modulator:

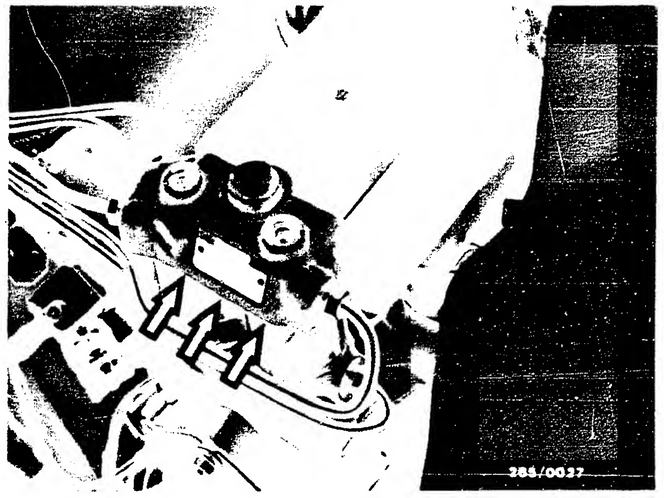
V = Front-axle brake circuit of staged tandem brake master cylinder

H = Rear-axle brake circuit of staged tandem brake master cylinder

1 = Lead to wheel brake cylinder, front left

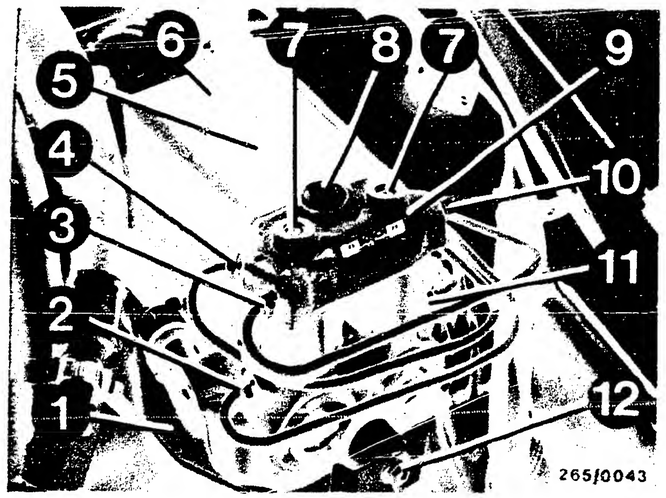
r = Lead to wheel brake cylinder, front right

h = Lead to the rear wheel brake cylinders.



Arrows = Sealing points

2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line



Removing the hydraulic modulator

* For safety reasons, the hydraulic modulator must not be repaired, but the complete unit must be replaced.

  Exceptions to this are the motor relay and the valve relay. Both relays may be replaced.

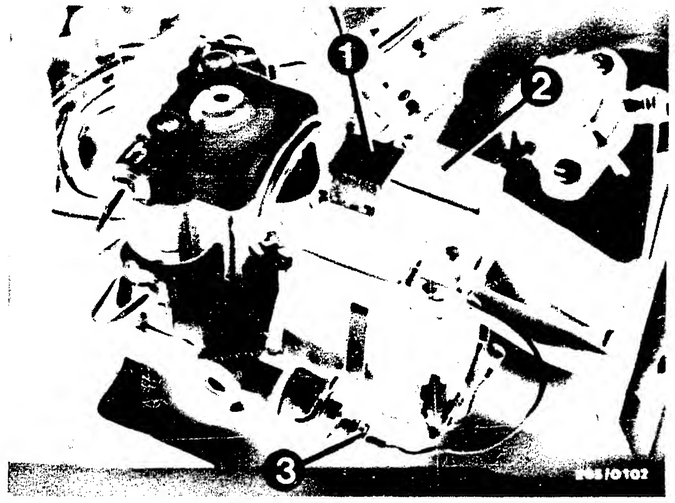
* Apart from the brake-line connections, it is not permissible to loosen any screws on the hydraulic modulator.

  In particular, the hexagon-socket-head cap screws may under no circumstances be loosened.

  After loosening, it is no longer possible to get the brake circuits leak-tight.
  D a n g e r!

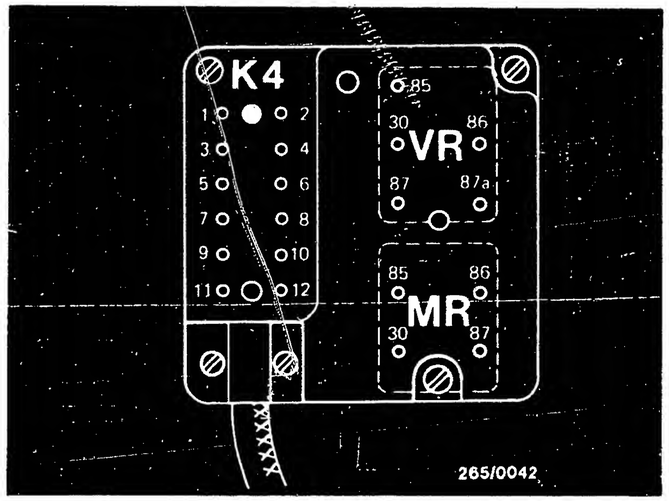
* Check the hydraulic modulator and brake-line connections for leaks by means of a visual examination.

If brake fluid is escaping, tighten the brake-line connections (12...16 Nm) or replace, or replace the hydraulic modulator.



1 = Valve relay
2 = Motor relay
3 = Ground terminal

Top view of printed-board assembly of hydraulic modulator
VR = Valve relay
MR = Motor relay
K4 = Kostal plug



TEST STEP 20 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Controller.
BITE triggering
(BITE = Built-in Test Equipment).

Operation:
Program-selector switch position: 16

Illuminated key lights up.
Press key at least 3 seconds.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
Watch ABS warning lamp in vehicle:
After illuminated key is pressed, warning lamp must go out within 1 second.
Warning lamp may flash 2 times.

Does warning lamp go out within 1 second?

N>

Trouble-shooting:

1. Repeat test step with engine running.

2. Replace controller (switch off ignition beforehand).

Note:

* Switch off ignition before disconnecting controller plug.

* Push back spring to disconnect controller plug. Bend controller plug upward and unhook from encoding block.

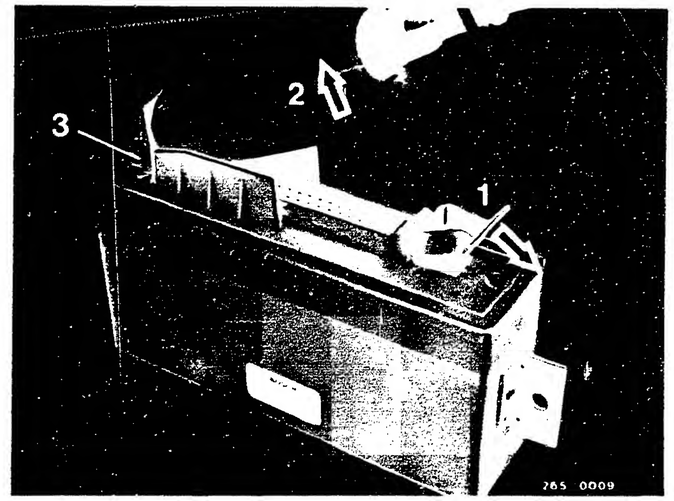
* Install specified controller only!

* When installing, make sure that the controller plug latches into the spring.

Y

V

Continued on next coordinate



1 = Spring
2 = Controller plug (35-pin)
3 = Encoding unit

TEST STEP 21 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

Component/Function:
Controller.
BITE sequence with fault simulation.
(BITE = Built-In Test Equipment)

Operation:
Program-selector switch position: 17

Illuminated key lights up.
Press key for at least 3 seconds.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
Watch ABS warning lamp in vehicle:
warning lamp must light up for as long as illuminated key is pressed.
Warning lamp may flash 2 times.

Does warning lamp light up for as long as illuminated key is pressed?

N>

Trouble-shooting:

1. Repeat test step with engine running.

2. Replace controller (switch off ignition beforehand).

Note:

* Switch off ignition before disconnecting controller plug.

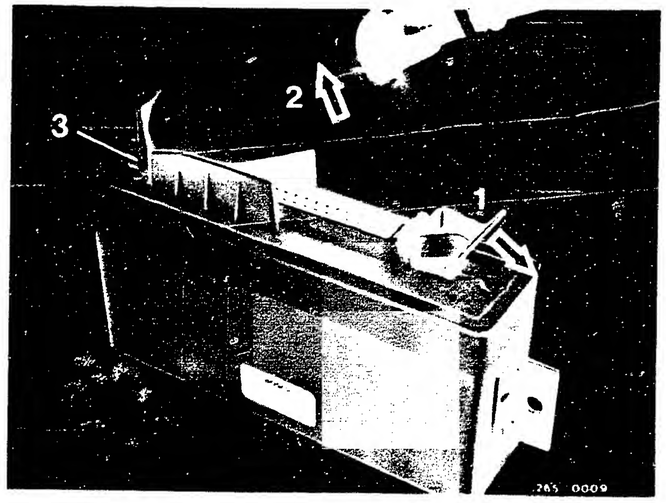
* Push back spring to disconnect controller plug. Bend controller plug upward and unhook from encoding block.

* Install specified controller only!

* When installing, make sure that the controller plug latches into the spring.

Y

Continued on next coordinate



1 = Spring
2 = Controller plug (35-pin)
3 = Encoding unit

Component/Function:
Controller.
Valve flows for pressure-holding.

N>

Operation:
Program-selector switch position: 18

Press the channel buttons VL, VR, HA one after the other. Illuminated key lights up. Press ill. key each time after press. a channel button.
Note:
Before pressing illuminated key, indicator must be at zero!

Operation in vehicle:
Switch on ignition.

Test specification (reading):
For each channel
1,9...2,3 A

Note:
Pump motor starts up.

Is measured value in each case within the test-specifications tolerance?

Y

Continued on next coordinate

Trouble-shooting:

1. Repeat test step with engine running.

2. Replace controller (switch off ignition beforehand).

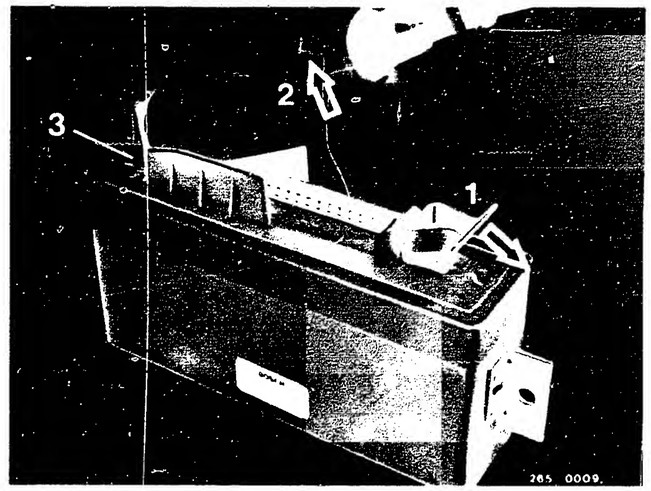
Note:
* Reading jumps to zero after a few seconds. If test step must be repeated, the key must be pressed again.

* Switch off ignition before disconnecting controller plug.

* Push back spring to disconnect controller plug. Bend controller plug upward and unhook from encoding block.

* Install specified controller only!

* When installing, make sure that controller plug latches into spring.



1 = Spring
2 = Controller plug (35-pin)
3 = Encoding unit

TEST STEP 23 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Controller.
Valve flows for pressure red.

Operation:
Program-selector switch position: 19

Press channel buttons VL, VR, HA one after the other. Illuminated key lights up. Press illuminated key each time after pressing a channel button.
Note:
Before pressing illuminated key, reading must be at zero!

Operation in vehicle:
Switch on ignition.

Test specification (reading):
For each channel
4,5...5,7 A

Note:
Pump motor starts up.

Is measured value in each case within the test-specifications tolerance?

N>

Trouble-shooting:

1. Repeat test step with engine running.

2. Replace controller (switch off ignition beforehand).

Note:
* Reading jumps to zero after a few seconds. If test step must be repeated, key must be pressed again.

* Switch off ignition before disconnecting controller plug.

* Push back spring to disconnect controller plug. Bend controller plug upward and unhook from encoding block.

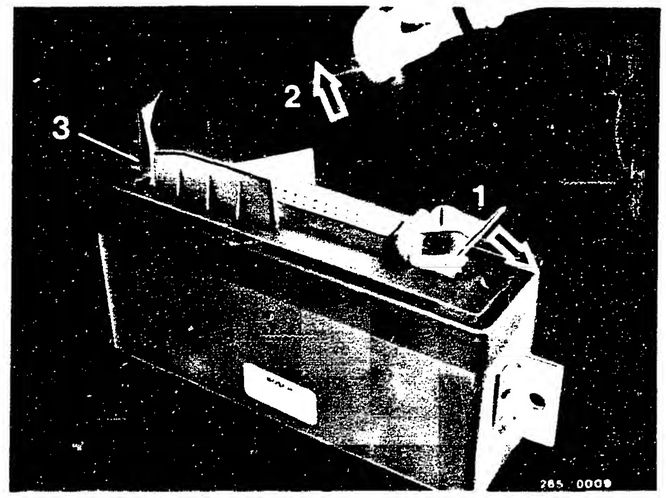
* Install specified controller only!

* When installing, make sure that controller plug latches into spring.

Y

V

Continued on next coordinate



1 = Spring
2 = Controller plug (35-pin)
3 = Encoding unit

TEST STEP 24 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Lead to stop-lamp switch.
Function built in as of 9.81
(generation 2 B).

Operation:
Program-selector switch position: 24

Operation in vehicle:
Switch on ignition.
Actuate brake pedal.

Test specification (reading):
10...15 V

Is measured value within the test-specifications tolerance?

Note:
Tester must be modified for generation 2 B.

N>

Trouble-shooting:

No reading:

Inspect stop-lamp switch including plug connections and leads.

Reading below 10 V:

The brake lamps are defective.
Eliminate contact resistances at plug connections or replace the stop-lamp switch.

Y

V

Continued on next coordinate

A dynamic brake analyzer (brake test stand) (BPS) is necessary for program-switch positions 20, 21, 22 and 23.

I M P O R T A N T !

Never drive with the tester connected!

Do not use a brake-pedal-actuating device to set the braking force!

Proceed with program-switch position 23 first, since the following test steps require that the wheel-speed sensors be in proper working order.

When switching channels, wait at least 20 seconds (internal tester program must complete).

Always observe the operating sequence.

Begin testing with the front axle.

For reasons of safety, it is vital that the tester be converted to the latest status.

Make sure of U2 marking, or as of FD 352 on the nameplate!

TEST STEP 25 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Left front wheel-speed sensor.
Signal and transposition of connection leads.

Operation:
Program-switch position: 23

* Drive the vehicle onto the brake test stand with the front wheels.
* Pull the parking brake.
  Important!
  On vehicles with automatic transmission, make sure that the selector level is in the "N" position.
* Select left front wheel with button VL.
* Switch on the left brake roller.
* Note the reading.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
1,9...19
If the reading fluctuates, the lowest value applies!
If the reading is at 1,9 bridge the air gap!

Is the measured value within the test-specification tolerance range ?

N>

Trouble-shooting:
(Switch off ignition)

A reading of 999 means:

Brake test stand speed excessive (above approx. 13 km/h).

Y

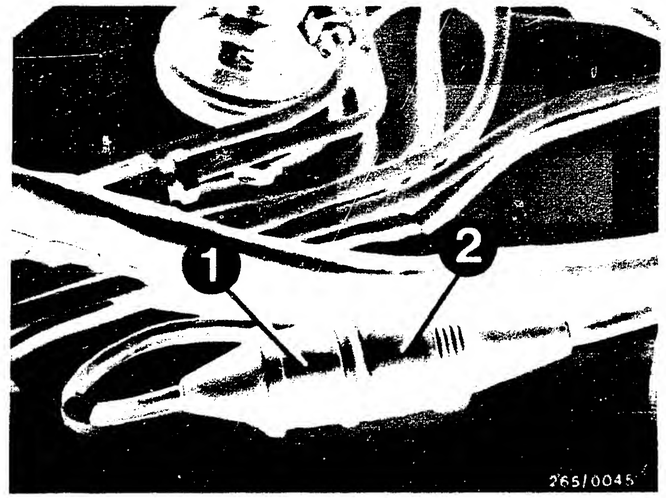
V

Y

V

Continued G01

Continued on next coordinate



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

F23 — <==>

F24 — <==>

Reading 0 or less than 1.9

* Are the wheel-speed sensors mixed up?
  Check for correct connection: The sensors must correspond to the prescribed wheel and controller input (see circuit diagram).

* Is the air gap between the wheel-speed sensor and the ring gear excessive?
  Check installation:
  Was wheel-speed sensor installed so it is resting against the stop in its recess?

* Check wheel bearing play.

* Replace wheel-speed sensor.

Removing wheel-speed sensors from front axles

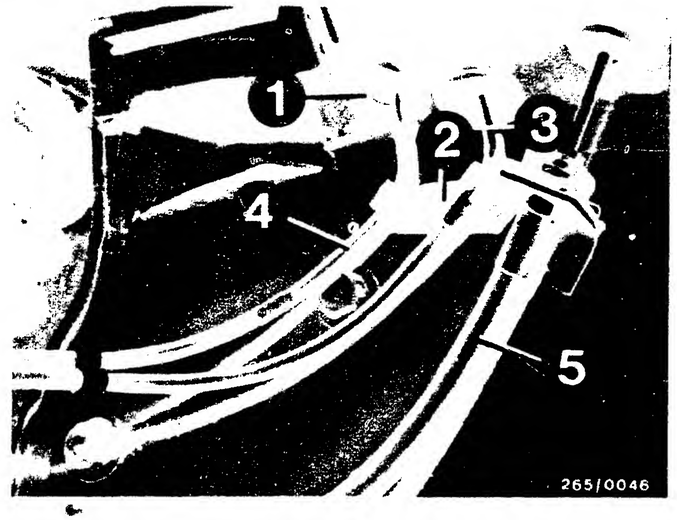
* Disconnect wheel-speed sensor plug connection in engine compartment.

* Remove lead (4) from holder (2) and pull down out of the wheel well through the rubber grommet (1)

* Remove the protective tube from the cover plate.

* Unscrew the fastenings of the lead on the wheel-bearing housing and wheel well.

* Unscrew the fastening screw for the wheel-speed sensor and pull the sensor out.
  Do not use force!



Cable routing in wheel well
1 = Rubber grommet
2 = Holder
3 = Cable for wear indicator
4 = Lead for wheel-speed sensor
5 = Brake hose

1 = Protective tube

* Unscrew Allen-head screw (3) and pull the wheel-speed sensor (1) out of the steering knuckle.

* Remove wheel-speed sensor complete with cable and protective tube.

Installing wheel-speed sensors on the front axle

The left and right wheel-speed sensors have differing protective tubes. For identification purposes, an L or R are stamped into the holders of the protective tubes.
Before installing the wheel-speed sensors, make sure that no metallic foreign objects are on the permanent-magnet tips.

* Grease the sensor housing with Molykote Longterm 2 lubricant.

* Press the sensor (1) carefully into the steering knuckle. Do not strike!
While doing this, make certain that the O-ring (4) does not become damaged.

* Fasten the wheel-speed sensor to the steering knuckle with an Allen-head screw (3). Self-locking Allen-head screws may be used only once.

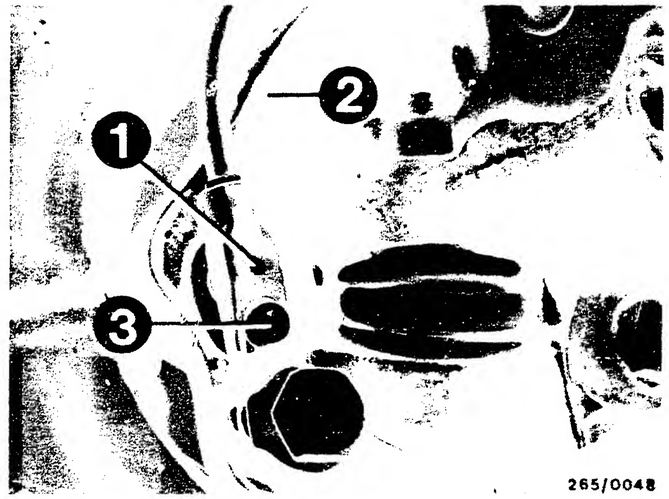
* Fasten the protection tube to the cover plate.

* Clip the lead into the holder and pull it through the rubber grommet into the engine compartment.

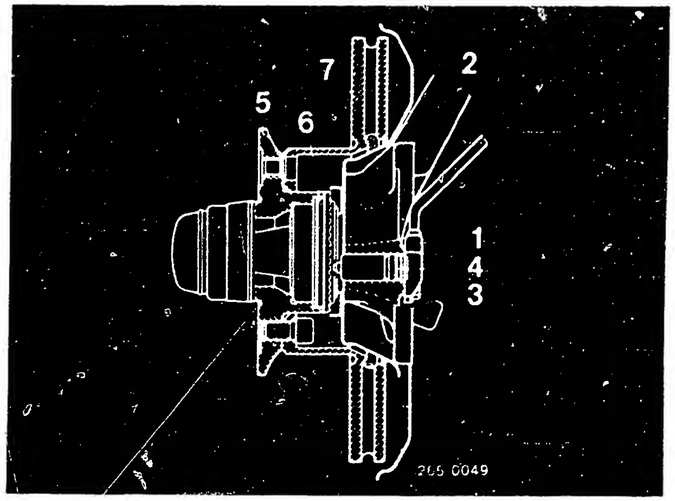
* Plug the coaxial plug connection together, making sure that the O-ring is correctly seated.

* After repair, test with ABS-tester.

Note:
On cars where the cables for the brake-pad wear indicator and the wheel-speed sensor are combined, when carrying out repairs convert to separate configuration. At the same time, the cable holder on the brake hose must be replaced.



1 = Wheel-speed sensor
2 = Steering knuckle
3 = Allen-head screw
4 = O-ring
5 = Front wheel hub
6 = Teeth (rotor)
7 = Brake disc



TEST STEP 26 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Right front wheel-speed sensor.
Signal and transposition of connection leads.

Operation:
Program-switch position: 23

* Drive vehicle onto brake test stand with front wheels.
* Pull the parking brake.
  Important:
  With vehicles having automatic transmission, make sure that the selector level is in the "N" position.

* Select right front wheel with button VR.
* Switch off the left brake roller and switch on the right brake roller.
* Note reading.

Operation in vehicle:
Switch off ignition.

Test specification (reading):
1,9...19
If the reading fluctuates, the lowest value applies!
If the reading is at 1,9 bridge the air gap!

Is the measured value within the test-specification tolerance range in each case ?

N>

Trouble-shooting:
(Switch off ignition)

A reading of 999 means:

Brake test stand speed excessive (above approx. 13 km/h).

Y

V

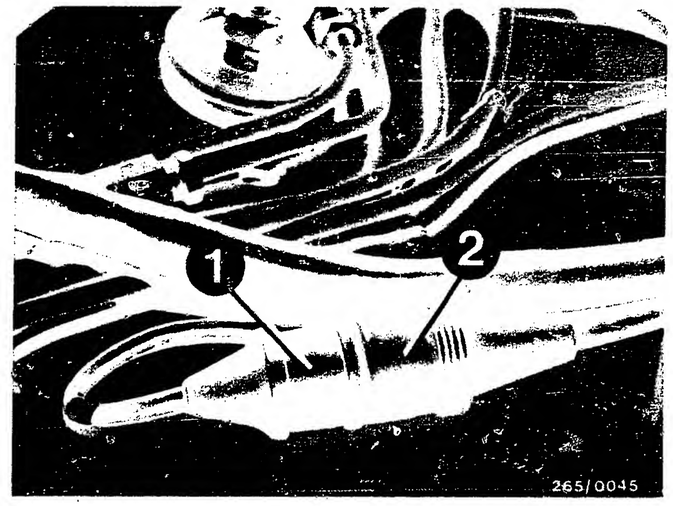
Y

V

Continued G07

V

Continued on next coordinate



Coaxial-entry plug connection
1 = Plug (to controller)
2 = Coupling
(to wheel-speed sensor)

Reading 0 or less than 1.9

* Are the wheel-speed sensors mixed up?
  Check for correct connection: The sensors must correspond to the prescribed wheel and controller input (see circuit diagram).

* Is the air gap between the wheel-speed sensor and the ring gear excessive?
  Check installation:
  Was wheel-speed sensor installed so it is resting against the stop in its recess?

* Check wheel bearing play.

* Replace wheel-speed sensor.

Removing wheel-speed sensors from front axles

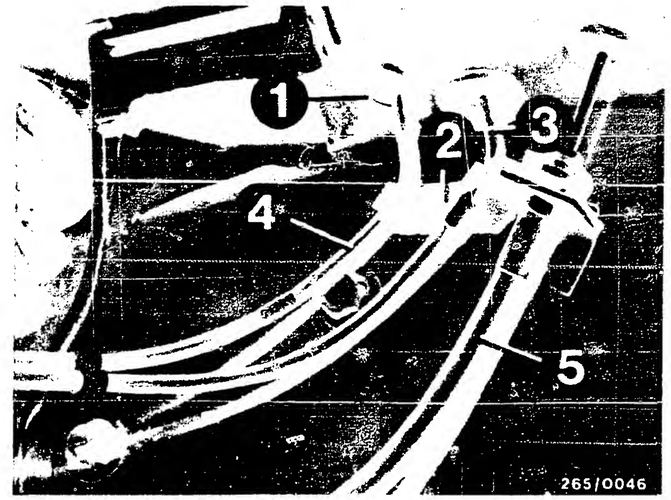
* Disconnect wheel-speed sensor plug connection in engine compartment.

* Remove lead (4) from holder (2) and pull down out of the wheel well through the rubber grommet (1)

* Remove the protective tube from the cover plate.

* Unscrew the fastenings of the lead on the wheel-bearing housing and wheel well.

* Unscrew the fastening screw for the wheel-speed sensor and pull the sensor out.
  Do not use force!



Cable routing in wheel well
1 = Rubber grommet
2 = Holder
3 = Cable for wear indicator
4 = Lead for wheel-speed sensor
5 = Brake hose

1 = Protective tube

* Unscrew Allen-head screw (3) and pull the wheel-speed sensor (1) out of the steering knuckle.

* Remove wheel-speed sensor complete with cable and protective tube.

Installing wheel-speed sensors on the front axle

The left and right wheel-speed sensors have differing protective tubes. For identification purposes, an L or R are stamped into the holders of the protective tubes.
Before installing the wheel-speed sensors, make sure that no metallic foreign objects are on the permanent-magnet tips.

* Grease the sensor housing with Molykote Longterm 2 lubricant.

* Press the sensor (1) carefully into the steering knuckle. Do not strike!
While doing this, make certain that the O-ring (4) does not become damaged.

* Fasten the wheel-speed sensor to the steering knuckle with an Allen-head screw (3). Self-locking Allen-head screws may be used only once.

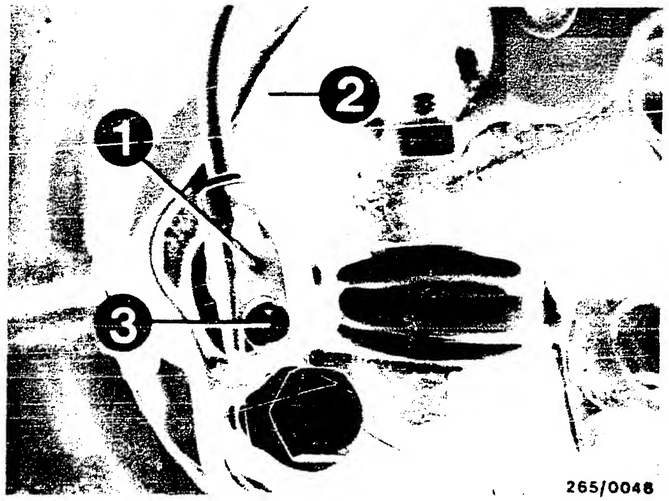
* Fasten the protection tube to the cover plate.

* Clip the lead into the holder and pull it through the rubber grommet into the engine compartment.

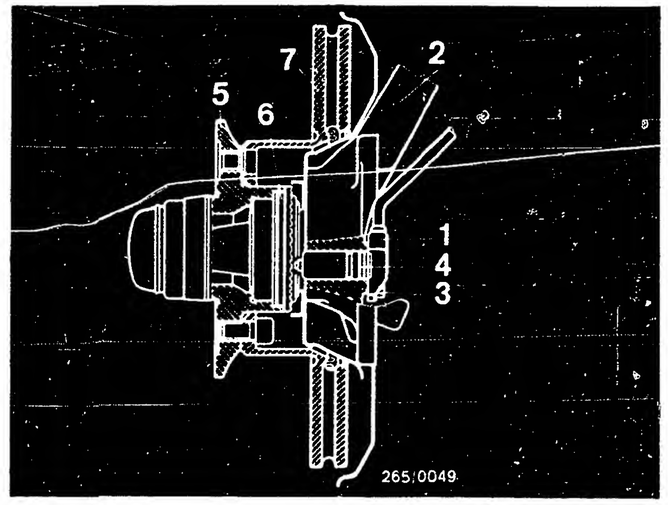
* Plug the coaxial plug connection together, making sure that the O-ring is correctly seated.

* After repair, test with ABS-tester.

Note:
On cars where the cables for the brake-pad wear indicator and the wheel-speed sensor are combined, when carrying out repairs convert to separate configuration. At the same time, the cable holder on the brake hose must be replaced.



1 = Wheel-speed sensor
2 = Steering knuckle
3 = Allen-head screw
4 = O-ring
5 = Front wheel hub
6 = Teeth (rotor)
7 = Brake disc



TEST STEP 27 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Check for correct connection of brake lines at front axle.

N>

Operation:
Program-switch position: 20

* Select left front wheel with button VL.
* Switch on the left brake roller.
* Depress the brake pedal until the braking-force reading on the brake test stand is 2000 N (200 kp).
* Press the illuminated button.
* There must be a pressure drop at the selected wheel (left front).
* Release the brake pedal and illuminated button (in that order - otherwise the vehicle will jump out of the rollers).

Operation in vehicle:
Let engine run.

Test specification (reading):
BPS reading for left wheel:
less than 1500 N (150 kp).

Is the measured value below 1500 N ?

Y

V

Continued on next coordinate

Trouble-shooting:

* Lamp 2 (red) must not light up.

* Repeat test.

* Brake lines at hydraulic modulator mixed up? Observe markings.

* Test assignment of dynamometer rollers to buttons VR and VL once again.

Markings on hydraulic modulator

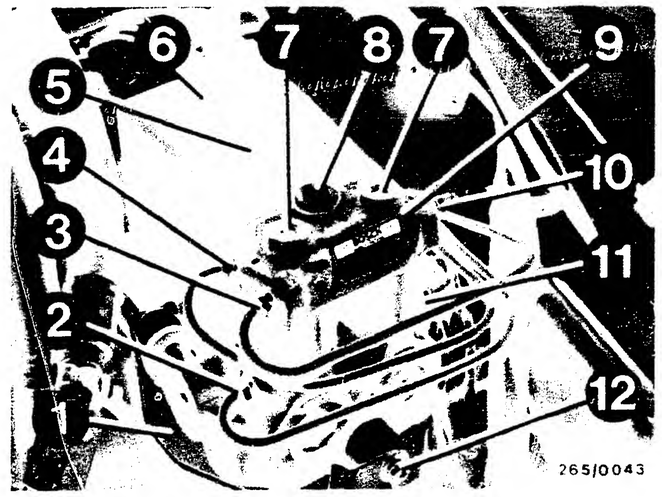
V = Front-axle brake circuit of staged brake master cylinder

H = Rear-axle brake circuit of staged brake master cylinder

l = Front-wheel brake, left

r = Front-wheel brake, right

h = Rear-wheel brake



2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line

I m p o r t a n t !
The Allen-head or Torx screws must never be loosened. If they are loosened, it is impossible to prevent leakage in the brake circuit. This can be fatal!

V

Component/Function:
Hydraulic modulator.
Test of correct connection of brake lines at the front axles.

Operation:
Program-switch position: 20

* Select right front wheel with button VR.
* Switch off the left brake roller, switch on the right brake roller.
* Depress the brake pedal until the braking-force reading on the brake test stand is 2000 N (200 kp).
* Press illuminated button.
* There must be a pressure drop at the selected wheel (right front).
* Release the brake pedal and illuminated button (in that order - otherwise the vehicle will jump out of the rollers).

Operation in vehicle:
Let engine run.

Test specification (reading).
BPS reading for right wheel:
less than 1500 N (150 kp)

Is the measured value below 1500 N ?

N>

Trouble-shooting:

* Lamp 2 (red) must not light up.
* Repeat test.
* Brake lines at hydraulic modulator mixed up? Observe markings.
* Test assignment of dynamometer rollers to buttons VR and VL once again.

Markings on hydraulic modulator

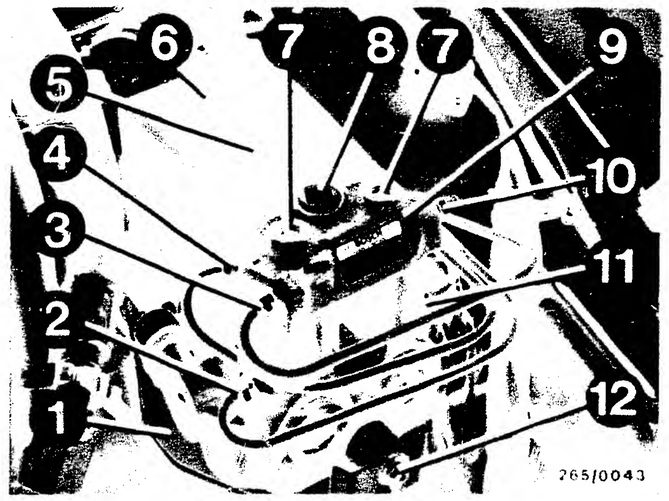
V = Front-axle brake circuit of staged brake master cylinder

H = Rear-axle brake circuit of staged brake master cylinder

l = Front-wheel brake, left

r = Front-wheel brake, right

h = Rear-wheel brake



2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line

I m p o r t a n t !
The Allen-head or Torx screws must never be loosened.
If they are loosened, it is impossible to prevent leakage in the brake circuit.
This can be fatal!

Y
V

Continued on next coordinate

TEST STEP 29 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Test of pressure reduction in wheel brake cyl., front left.
Operation:
Program-selector switch position: 20

* Switch on left-hand and right-hand dyn. rollers.
* Select wheel VL with button VL.
* Actuate brake pedal until brake dyn. instrument indicates 2000 N (200 kgf) for left-hand side.
  Pedal braking force must not be changed during entire test sequence!
* Right-hand reading may deviate from left-hand reading by max. 500 N (50 kgf).
* Press illuminated key until test is complete (approx. 10 seconds).
* Read off l-h. reading.
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle:
Leave engine running.
Test specification (reading):
Reading on BPS for left-hand wheel 500...1100 N (50...110 kgf)
Is measured value smaller than 500 N
or greater than 1100 N?

N>

Y

V

Continued on next coordinate

Trouble-shooting:

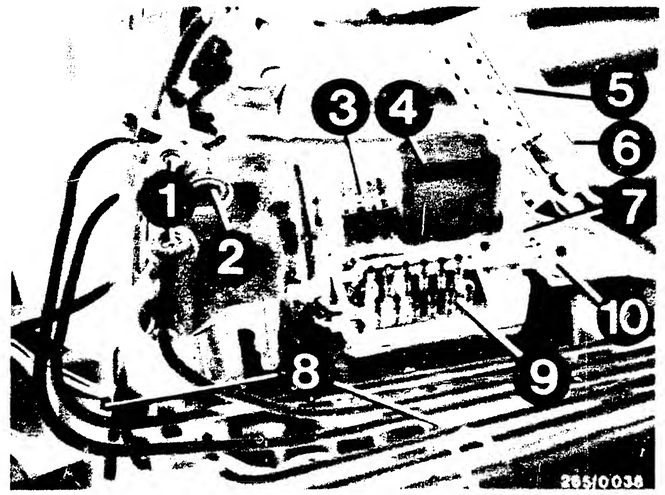
* Lamp 2 (red) must not light up.

* Repeat testing twice and make sure that the braking force is not altered during testing.

* Is the rest of the brake system OK ? Well bleed ?
  Are the brake-line connections sealed ? Are the brake linings OK ?
  The brake linings must not be "glassy".
  Are the brake disks OK ?
  The brakes must be generally "grippy".
  Are the master and wheel cylinders OK ?
  The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Check the ground terminal on the pump motor and the body.

* Check the positive terminal on the pump motor.

* Replace the hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 30 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Test of pressure reduction in right front wheel brake cylinder.

N>

Operation:
Program-switch position: 20

* Switch on the left and right brake rollers.
* Select the right front wheel with the VR button.
* Depress the brake pedal until the brake test stand instrument shows 20 00 N (200 kp). for right.
  The pedal braking force must not be changed during the entire test!
* The right reading may deviate from the left reading by max. 500 N (50 kp).
* Depress the illuminated button until testing is over (approx. 10 seconds).
* Read the right reading.
* Release the brake pedal and illuminated button (in that order).

Operation in vehicle:
Let engine run.

Test specification (reading):
BPS reading for right wheel less than 1100 N (110 kp).

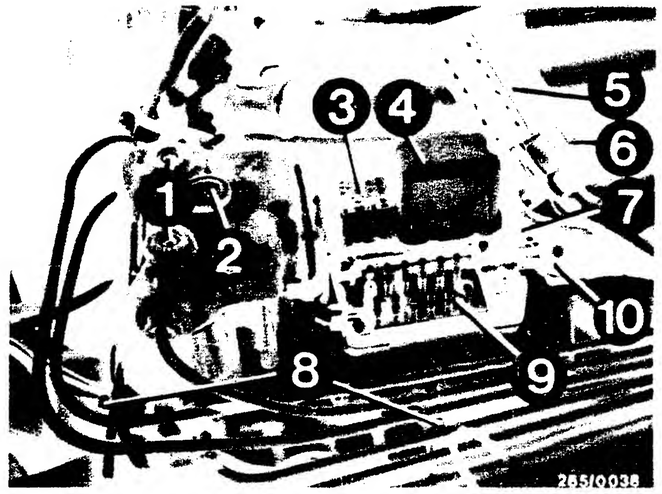
Is the measured value below 1100 N ?

Y
V

Continued on next coordinate

Trouble-shooting:

* Lamp 2 (red) must not light up.
* Repeat the test twice. Make sure that the braking force mains unaltered during the entire test (let engine run).
* Is the rest of the brake system OK ? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? Brake linings must not be "glassy". Brake disks OK ? The brakes must be generally "grippy". Are the main and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect the ground terminals on the pump motor and body.
* Check positive terminal at pump motor.
* Replace the hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 31 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Test of pressure buildup in wheel-brake cylinder, front left.

N>

Operation:
Program-selector switch position: 21
* Switch on both dyn. rollers.
* Select front left wheel with button VL
* Actuate brake pedal until brake dyn. instrument indicates 2000 N (200 kgf) for l-h. side.
* Pedal braking for force must not be changed during entire test sequence!
* Press illuminated key until test is complete (approx. 10 seconds).
* Read off left-hand reading.
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle:
Leave engine running.
Test specification (reading):
Reading on BPS for left-hand wheel returns to an intermediate value smaller than 500 N (50 kgf) and then rises to 1000...1700 N (100...170 kgf).

Measured value O.K.?

Y

V

Continued on next coordinate

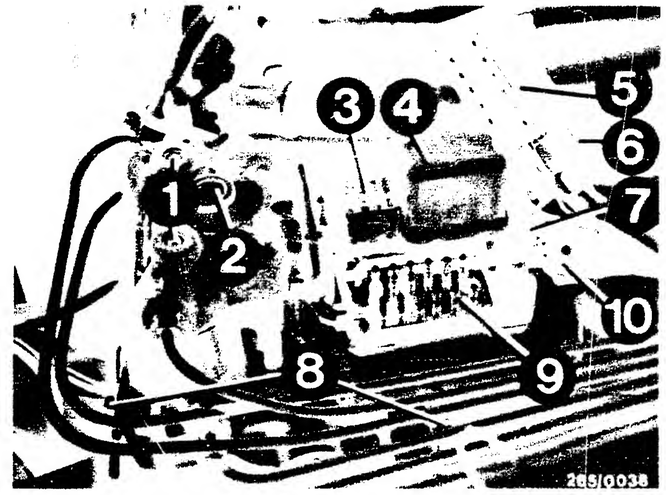
Trouble-shooting:

* Repeat testing twice and make sure that the braking force is not altered during testing (let engine run).

* Is the rest of the brake system OK? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? The brake linings must not be "glassy". Brake disks OK ? The brakes must be generally "grippy". Are the master and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect the ground terminals on the pump motor and the body.

* Check positive terminal on pump motor.

* Replace the hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 32 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Test of pressure buildup in wheel brake cyl., front right

N>

Operation:
Program-selector switch position: |21|

* Switch on both dyn. rollers.
* Select front right wheel with button VR.
* Actuate brake pedal until brake dyn. instrument indicates 2000 N (200 kgf) for right-hand side.
* Pedal braking force must not be changed during entire test sequence!
* Press illuminated key until test is complete (approx. 10 seconds)
* Read off right-hand reading
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle:
Leave engine running.
Test specification (reading):
Reading on BPS for right wheel returns to an intermediate value smaller than 500 N (50 kgf) and then rises to 1000...1700 N (100...170 kp).
Measured value O.K.?

Y

V

Continued on next coordinate

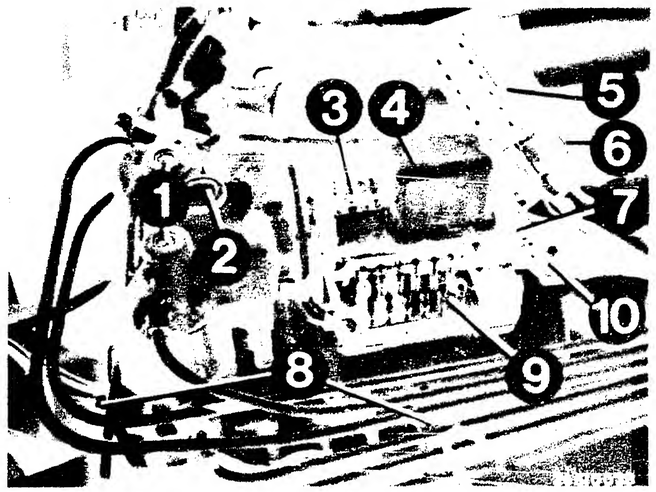
Trouble-shooting:

* Repeat testing twice and make sure that the braking force is not altered during testing (let engine run).

* Is the rest of the brake system OK? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? The brake linings must not be "glassy". Brake disks OK ? The brakes must be generally "grippy". Are the master and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect the ground terminals on the pump motor and the body.

* Check positive terminal on pump motor.

* Replace the hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 33 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Pump delivery in 1st brake circuit.

N>

Operation:
Program-switch position: 22
* Switch on both brake rollers.
* Note rolling friction of left wheel.
* Select left front wheel with button VL.
* Depress brake pedal until brake test stand instrument shows 2000 N (200 kp) for left.
* Pedal braking force must not be changed during the entire test!
* Depress the illuminated button until testing is over (approx. 10 seconds).
* Note left reading.
* Release brake pedal and and illuminated button (in that order.)

Operation in vehicle:
Let engine run.

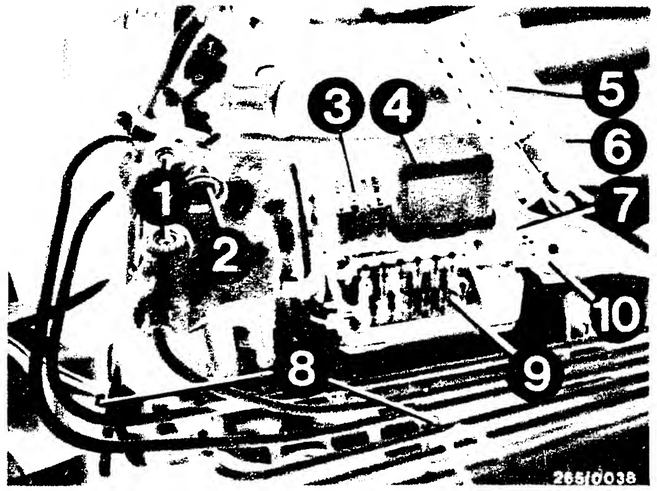
Test specification (reading):
The BPS reading for the left wheel must drop below the rolling friction plus
max. 500 N (50 kp). 1)
Is the measured value OK ?

Y
V

Continued on next coordinate

1) Note:
After pressing the illuminated button, there will be pressure reduction 2 times without return pump.
The return pump will then briefly switch on.
The brake pedal will then show noticable return pressure.
Do not note the test value until within approx. 2,5 seconds after the return pump has switched on.
Depress the illuminated button until the reading returns to full braking force.

Trouble-shooting:
* Repeat test twice and make sure that the braking force is not altered during testing (let engine run).
* Is the rest of the brake system OK ? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? The brake linings must not be "glassy". Are brake disks OK ? The brakes must be generally "grippy". Are the main and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect ground terminals on pump motor and body.
* Check positive terminal at pump motor.
* Replace hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 34 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Wheel-speed sensors, rear axle.
Signal and mix-up of connecting leads.

Operation:
Program-selector switch position: 23

* Drive rear wheels of vehicle onto brake dyn.
* Release hand brake.
  Attention!
  For vehicles with automatic transmission, selector switch in Park pos.
* Select rear-axle wheels with button HA.
* Switch on both dyn. rollers.
* Read off reading.

Operation in vehicle:
Switch on ignition.

Test specification (reading):
1,9...19
If reading fluctuates, lowest value applies!
If reading at 1,9
check air gap!

Is measured value within the test-specifications tolerance?

N>

Trouble-shooting:
(Switch off ignition)

A reading of 999 means:

Brake test stand speed excessive (above approx. 13 km/h).

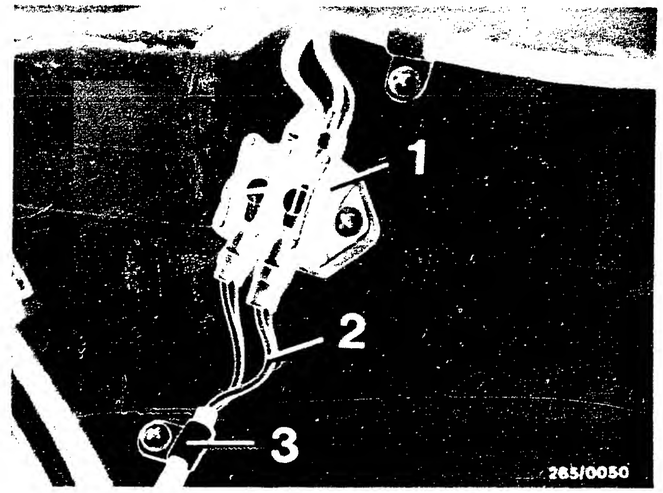
Y

V

Continued G27

V

Continued on next coordinate



1 = Multiple butt connector
2 = Lead
3 = Clamp

G21 — <==>

G22 — <==>

Trouble-shooting (switch off ignition)

1. Measure internal resistance at multiple butt connector.
   If set value is not reached: Replace wheel-speed sensor.

2. Check the following leads for continuity:
   From plug K15 to controller plug K1/terms.7 and 9.

3. Inspect screwed connections.

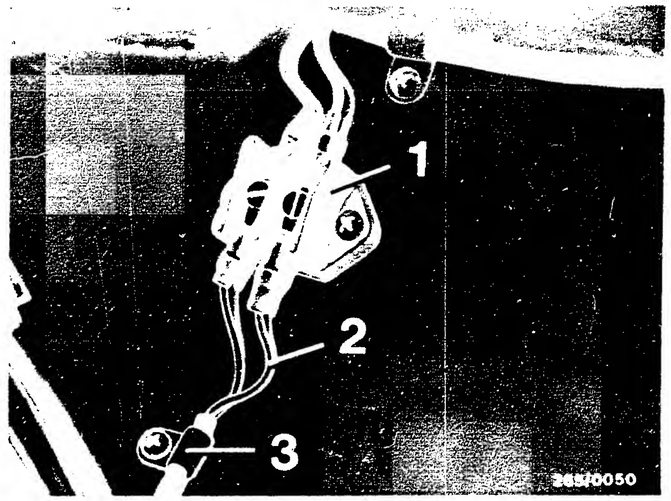
Removing the wheel-speed sensor from the rear axle:

* Remove the rear seat bench and backrest.

* Switch off ignition and disconnect leads in multiple butt connector; unscrew clamps.

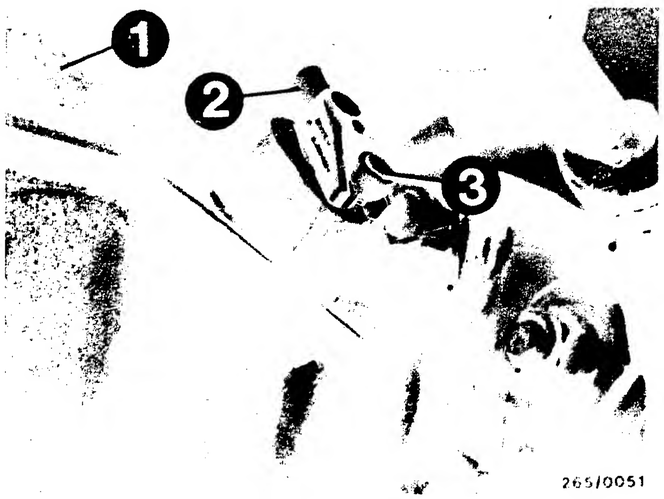
* Pull the lead downwards through the rubber grommet in the frame floor and the axle support.

* Unscrew Allen-head screw (3) and take the wheel-speed sensor (2) out of the rear-axle housing (1).



1 = Multiple butt connector
2 = Lead
3 = Clamp

1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw



Installing the wheel-speed sensor at the rear axle

I M P O R T A N T !

Before installing the wheel-speed sensor, make sure that there are no metallic foreign bodies on the permanent-magnet tip.

* Replace O-ring!

* Grease the wheel-speed sensor with Molykote Longterm 2 lubricant.

* Insert the wheel-speed sensor (2) into the rear-axle housing (1), making sure that the O-ring (4), does not become damaged. Do not use force.

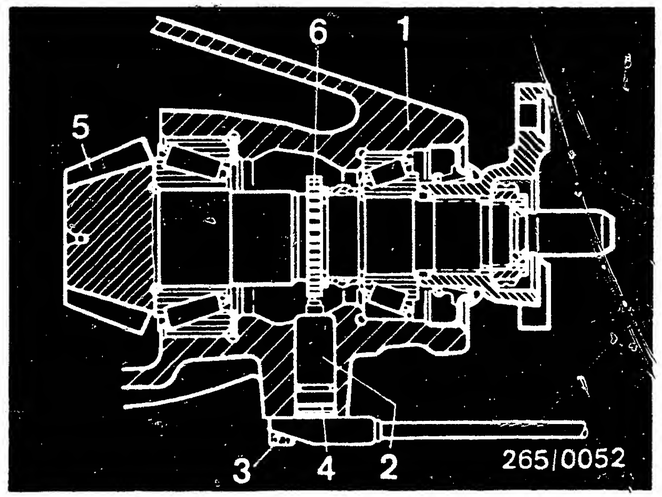
* Fasten the sensor to the rear-axle center housing with the Allen-head screw (3). The self-locking Allen-head screw may be used only once.

* Pull the lead for the wheel-speed sensor upwards through the rubber grommet in the axle support and frame floor and connect to the multiple butt connector.

* Fasten the wheel-speed sensor lead with clamps.

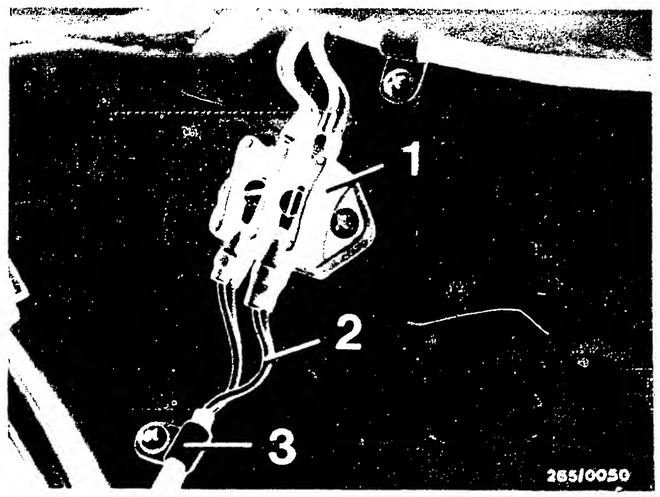
* Install the rear seat bench and backrest.

* After repair test with ABS-tester.



1 = Rear-axle housing
2 = Wheel-speed sensor
3 = Allen-head screw
4 = O-ring
5 = Drive bevel gear
6 = Gear (rotor)

1 = Multiple butt connector
2 = Lead
3 = Clamp



TEST STEP 35 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

Component/Function:
Hydraulic modulator, test of pressure reduction in wheel brake cyls. of rear axle.
Operation:
Program-selector switch position: 20

* Switch on both dyn. rollers.
* Select rear axle with button HA.
* Actuate brake pedal until dyn. instrument indicates 2000 N (200 kgf) for left-hand side.
  Pedal braking forces must not be changed during entire test sequence!
* Right-hand reading may deviate from left-hand reading by max. 500 N (50 kgf).
* Press illuminated key until test is complete (approx. 10 seconds).
* Read off left hand reading
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle:
Leave engine running.
Test specification (reading):
Reading on BPS for both wheels:
smaller than 1100 N (110 kgf)
Is measured value smaller than 1100 N?

N>

Y

Continued on next coordinate

Trouble-shooting:

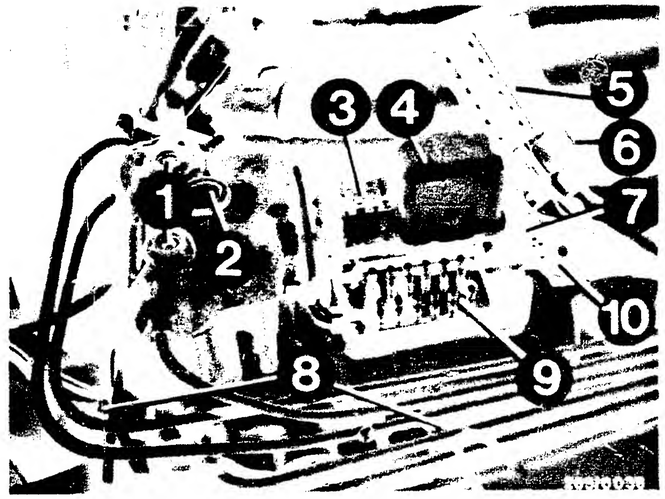
* Lamp 2 (red) must not light up.

* Repeat testing twice and make sure that the braking force is not altered during testing.

* Is the rest of the brake system OK ? Well bleed ?
  Are the brake-line connections sealed ? Are the brake linings OK ?
  The brake linings must not be "glassy".
  Are the brake disks OK ?
  The brakes must be generally "grippy".
  Are the master and wheel cylinders OK ?
  The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Check the ground terminal on the pump motor and the body.

* Check the positive terminal on the pump motor.

* Replace the hydraulic modulator.



1 = Allen-head screws
2 = Central screw
3 = Valve relay
4 = Motor relay
5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

TEST STEP 36 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

Component/Function:
Hydraulic modulator.
Test of pressure buildup in wheel brake cyls., rear.

Operation:
Program-selector switch position: 21
* Switch on both dyn. rollers.
* Select rear wheels with button HA.
* Actuate brake pedal until dyn. instrument indicates 2000 N (200 kgf) for left-hand side.
* Pedal braking force must not be changed during entire test sequence!
* Press illuminated key until test is complete (approx. 10 seconds).
* Read off left-hand reading.
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle.:
Leave engine running.

Test specification (reading):
Reading on BPS for left wheel returns to an intermediate value and then rises to 1000...1700 N (100...170 kgf)
Measured value O.K.?

N>

Trouble-shooting:

* Repeat testing twice and make sure that the braking force is not altered during testing (let engine run).

* Is the rest of the brake system OK? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? The brake linings must not be "glassy". Brake disks OK ? The brakes must be generally "grippy". Are the master and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect the ground terminals on the pump motor and the body.

* Check positive terminal on pump motor.

* Replace the hydraulic modulator.

Y

Continued on next coordinate

TEST STEP 37 (TEST SPECIFICATIONS AND NOTES ON OPERATION)

V

Component/Function:
Hydraulic modulator.
Pump delivery rate in 2nd brake circuit.

Operation:
Program-selector switch position: 22
* Switch on both dyn. rollers.
* Select rear axle with button HA.
* Actuate brake pedal until dyn. instrument indicates 2000 N (200 kgf) for right-hand side.
* Pedal braking force must not be changed during entire test sequence!
* Press illuminated key until test is complete (approx. 10 seconds).
* Read off right-hand reading.
* Release brake pedal and illuminated key (observe operating sequence).

Operation in vehicle:
Leave engine running.

Test specification (reading):
Reading on BPS for right wheel must drop below rolling friction plus max. 500 N (50 kgf). 1)

Measure value O.K.?

N>

1) Note:
After pressing the illuminated button, there will be pressure reduction 2 times without return pump.
The return pump will then briefly switch on.
The brake pedal will then show noticable return pressure.
Do not note the test value until within approx. 2,5 seconds after the return pump has switched on.
Depress the illuminated button until the reading returns to full braking force.

Trouble-shooting:
* Repeat test twice and make sure that the braking force is not altered during testing (let engine run).
* Is the rest of the brake system OK ? Well ventilated ? Are the brake-line connections sealed ? Brake linings OK ? The brake linings must not be "glassy". Are brake disks OK ? The brakes must be generally "grippy". Are the main and wheel brake cylinders OK ? The wheel brake cylinders and brake linings must show freedom of motion, if necessary clean them.
* Inspect ground terminals on pump motor and body.
* Check positive terminal at pump motor.
* Replace hydraulic modulator.

Y

V

Continued on next coordinate

Replacement of hydraulic modulator

Is replacement not necessary ? N>

Y

Testing with the ABS tester has been completed.

As a final test, carry out a test drive:
With the engine running or when 6 km/h is exceeded, the warning lamp should go out.

Drive at least 30 km/h. The warning lamp must not come back on.

Removing the hydraulic modulator:

* For safety reasons, the hydraulic modulator must not be repaired, but may only be replaced complete.

The motor and valve relays are excepted.
Both relays may be replaced.

* With the exception of the brake-line connections, no screws on the hydraulic modulator may be loosened.

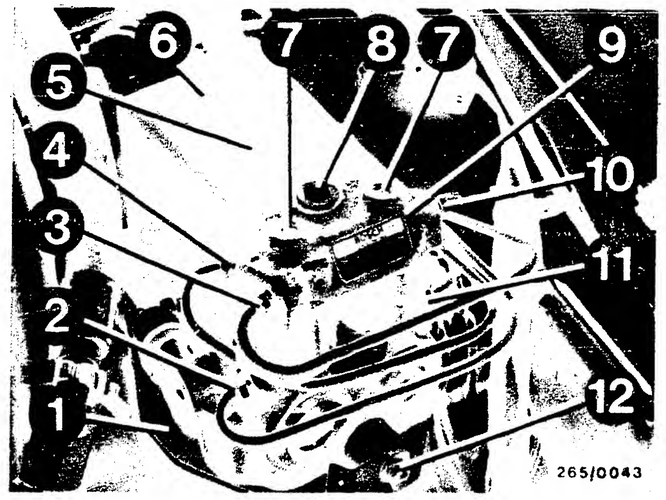
The Allen-head screws (arrows) in particular must under no circumstances be loosened.

After they are loosened, the brake circuits cannot be re-sealed!
This can be fatal!

* Visually inspect the hydraulic modulator and brake-line connections for leakage.

If brake fluid escapes, tighten the brake-line connections (12...16 Nm) or replace/exchange the hydraulic modulator.

Continued on next coordinate



1 = Holder
2 = Brake line, front-axle circuit
3 = Left front brake line
4 = Right front brake line
5 = Fastening screw
6 = Hood
7 = Allen-head screw
8 = Central screw
9 = Hydraulic modulator
10 = Rear brake line
11 = Brake line, rear-axle circuit
12 = Fastening nut

Pay particular attention to the joint identified by the arrows (upper illustration).

On the base of the hydraulic modulator there is a vent hole to the pump pistons.

A slight escape of brake fluid is possible at this point.

A complaint is only justified if, after pressing the brake pedal several times, a pool of brake fluid is formed under the hydraulic modulator.

* When removing and installing the brake lines, make sure that the lines are marked in accordance with the markings on the hydraulic modulator and that they are not mixed up when re-connecting (e.g. VL of hydraulic modulator must be connected to the front left wheel brake cylinder).

* Markings on hydraulic modulator:

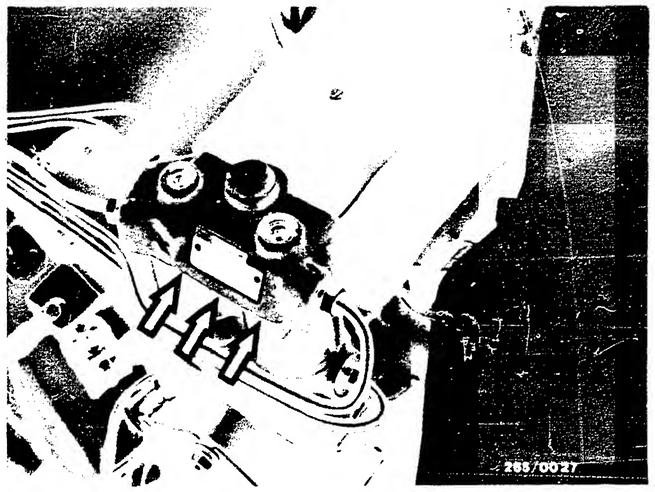
V = Front-axle brake circuit of staged tandem brake master cylinder

H = Rear-axle brake circuit of staged tandem brake master cylinder

l = Lead to wheel brake cylinder, front left

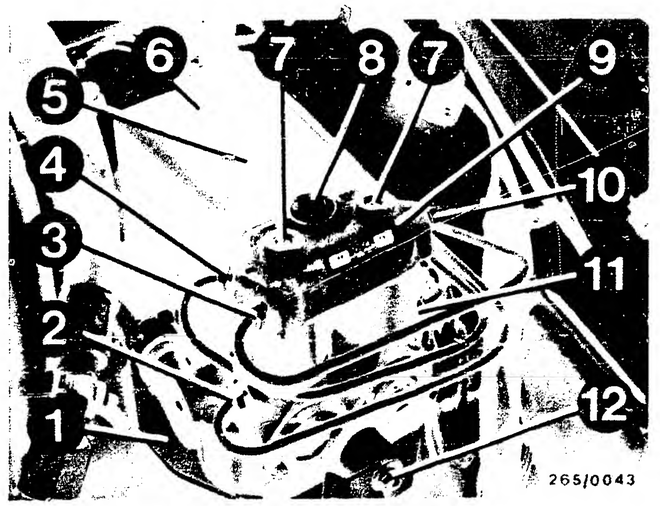
r = Lead to wheel brake cylinder, front right

h = Lead to the rear wheel brake cylinders.



Arrows = Sealing points

2 = Front-axle circuit brake line
3 = Left front brake line
4 = Right front brake line
9 = Hydraulic modulator
10 = Rear brake line
11 = Rear-axle circuit brake line



* Use only the prescribed 9 x 11 mm double-headed box wrench for loosening and tightening the brake lines.

* Mark brake lines 2 to 6 and disconnect from the hydraulic modulator.

* Catch the brake fluid and do not let it get on skin, clothing, or paint!

* Immediately plug brake lines and ports with dummy plugs.

* Disconnect the ground lead (7) at the pump motor..

* Unscrew the fastening screw and remove the hood.

* Loosen the clip (6) and remove the plug (5).

* Unscrew the hex nuts (8) and remove the hydraulic modulator.

Installing the hydraulic modulator

* Place the hydraulic modulator in the holder and fasten with the hex nuts (8).

* Connect ground lead to pump motor. Plug in the 12-pin plug (5) and fasten with the clip (6).

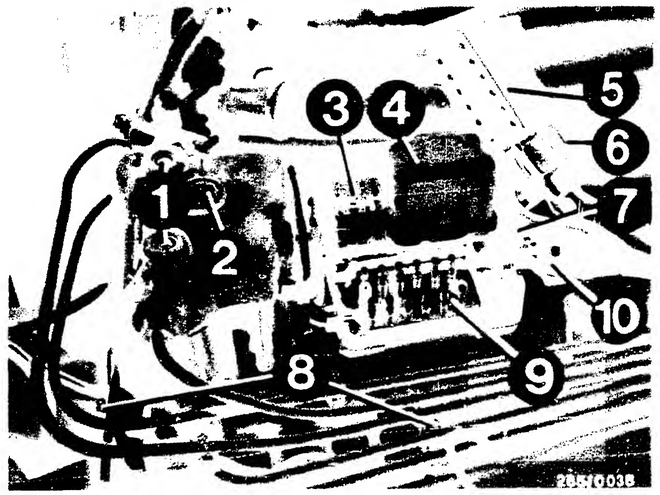
* Screw the hood onto the hydraulic modulator.

* Connect brake lines to the hydraulic modulator in accordance with the markings.

* Observe the tightening torque for connecting brake lines to the hydraulic modulator: 12...16 Nm.

* Bleed the brake system and check for leakage.

* Carry out a complete test of the ABS using the tester.



5 = Plug (K3)
6 = Clip
7 = Ground lead
8 = Fastening nut
9 = Plug base (K4)
10 = Positive terminal

13...39
VDT-I-265/101 En
08.1984

INDEX OF PASSENGER-CAR ABS SERVICE CENTERS INSIDE AND OUTSIDE GERMANY

supersedes Ed. 04.1983

The below-listed firms meet the requirements for performing after-sales service on BOSCH PASSENGER-CAR ABS systems 2 and 2 B and have the necessary service equipment.

Wilhelm Wissel GmbH & CO. KH
Bosch-Vertragsgroßhändler
Würzburger Str. 62 – 68
8750 Aschaffenburg

Otto Dürr KG
Bosch-Vertragsgroßhändler
Biberbachstraße 1
8900 Augsburg

Alber GmbH
Bosch-Dienst
Industriestraße 17
7150 Backnang

A. Rexroth
Bosch-Dienst
Kleine Industriestr.11
6430 Bad Hersfeld

Knobel & Keydel
Bosch-Vertragsgroßhändler
Thyssenstraße 1 – 5
1000 Berlin 51

Gebr. Roskoden
Bosch-Vertragsgroßhändler
Sachsendamm 2
1000 Berlin 62

Ing. Josef Kalveram
Bosch-Vertragsgroßhändler
Hallenstraße 9 – 11
4800 Bielefeld

Brunn GmbH & Co. KG
Bosch-Vertragsgroßhändler
Jusutus-von-Liebig-Str.24
5300 Bonn

Philipp Wolf GmbH & Co.KG
Bosch-Vertragsgroßhändler
Hannoversche Straße 33/34
3100 Celle

Bunte & Knebelkamp GmbH
Bosch-Dienst
Daimler-Straße 8
4590 Cloppenburg

Georg Gening GmbH
Bosch-Dienst
Abschnede 205
2190 Cuxhaven

Franz Strobl GmbH & Co.
Bosch-Vertragsgroßhändler
Otto-Röhm-Straße 68
6100 Darmstadt

Eugen Boss GmbH & Co.KG
Bosch-Vertragsgroßhändler
Rosemeyerstr. 14
4600 Dortmund

Soeffing GmbH & Co.
Bosch-Vertragsgroßhändler
Mindener Str. 12 – 26
4000 Düsseldorf

Vinzenz Radi KG
Inh. Frank Bischoff
Bosch Service
Spitalstraße 10
7930 Ehingen

Emil Schmolk GmbH
Bosch Dienst
Weiherstraße 2
7830 Emmendingen

A – E Wilhelm Gerhardt
Bosch-Dienst
Wolfsbankring 23
4300 Essen-Borbeck

Dipl.-Ing. Karl Schmitt
Bosch-Vertragsgroßhändler
Ohmstraße 1 – 9
6000 Frankfurt (Main) 90

Keller & Schneider GmbH
Bosch-Vertragsgroßhändler
Lörracher Str. 43
7800 Freiburg

Armin Eschenbacher
Bosch-Dienst
Frankfurter Str. 29
8780 Gemünden

Ludwig Fetzer GmbH & Co.KG
Bosch-Vertragsgroßhändler
Steinstraße 81 – 83
6300 Gießen

Alfred Kruse Nachf.GmbH&Co.
Bosch-Vertragsgroßhändler
Eiffestraße 10
2000 Hamburg 26

Peters
Bosch – Dienst
Winsener Str. 231
2100 Hamburg 90

August Coler
Bosch-Dienst
Münsterstr. 6 b
4700 Hamm

Hans Habenicht KG
Bosch-Service
Sandstraße 6 – 8
3000 Hannover

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TECHNICAL BULLETIN

13....39
REPAIR PROHIBITION / VDT-I-265/102 En...
MAXIMUM ALLOWABLE STORAGE TIME 1.1986
FOR ABS HYDRAULIC MODULATORS

Replaces edition of 7.1984

1. Repair prohibition

ABS for passenger vehicles is a safety system.
Unauthorized tampering with ABS components brings with it the danger of impairment of the proper functioning of the ABS system.

For reasons of safety, therefore, the
hydraulic modulator may under no circum-
stances be repaired, but instead must be
exchanged as a complete unit.

Only the engine and valve relays may be exchanged.
No other screws or plugs may be loosened or removed.

2. Maximum allowable storage time

The maximum allowable storage time for hydraulic modulators is 5 years from the date of manufacture (FD) specified on the product.

This requires that the following storage conditions be fulfilled:
- Hydraulic modulator filled with brake fluid (supplied in filled condition).
- Vertical/upright position (hood on top).
- Ambient temperature between -20°C and +50°C.
- Dry storage.

After 5 years storage time, all rubber and plastic parts must be replaced and the hydraulic modulator must be subjected to a functional test.

The replacement of rubber and plastic parts and the functional test can be carried out only at the place of manufacture. After testing, the hydraulic modulators are marked with |L| and a new date of manufacture (FD).

Service workshops in the Federal Republic of Germany should send the hydraulic modulators to:
Robert Bosch GmbH Abt. K1/VAK 2,
Robert-Bosch-Straße, 7141 Schwieberdingen.
Service workshops in other countries are requested to send the hydraulic modulators to:
Robert Bosch GmbH, KH/LAV 2 - Auspackraum,
z.W. an K1/VAK 2, Auf der Breit 4,
D-7500 Karlsruhe 41
West Germany.

The hydraulic modulators should be sent to us pre-paid.
Please refer to this Technical Bulletin on the enclosed delivery ticket.
A fee is charged for parts replacement and functional testing.

Responsible:
ROBERT BOSCH GMBH
Division KH
Technical After-Sales Service (KH/VKD 2)
Please address questions and comments concerning the contents to our authorized representative in your country.

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